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INTERNATIONAL METEOROLOGICAL ORGANIZATION
Second Telecommunications Sub-Commission Meeting, Stockholm, April 1949

By C. V. OCKENDEN, B.Sc.

The second meeting of the I.M.O. European Regional Sub-Commission for the Transmission of Weather Information was held at Stockholm from April 20 to May 4 and was attended by delegates from seventeen countries. The Conference took place in the Swedish Meteorological Institute under the presidency of Dr. Bjorkdal in the absence of Dr. Ångström who was attending the Second Conference of the International Civil Aviation Organization (I.C.A.O.) North Atlantic Ocean Stations in London. As at the first meeting which was held in London in May 1948* the questions discussed fell naturally under two main headings—the collection and dissemination of data within Europe by W/T and by teleprinter. Mr. Rafalowski (Poland) and Mr. Ockenden (United Kingdom) were elected Chairmen of sub-committees to study Agenda items which fell under these two headings.

The Scandinavian countries are now making considerable use of teleprinter land-lines, and a plan was evolved which will provide Denmark, Norway and Sweden with as much as possible of the international meteorological data, including North American data, which are broadcast by the four main teleprinter centres, Dunstable, Paris, Frankfurt and B.A.F.O. The circuits envisaged will also provide a " ring system " for the exchange of data between the Scandinavian countries themselves and will ultimately permit observations from Finland, as well as collectives from Oslo, Stockholm and Copenhagen, being fed into the international network.

Switzerland and Italy now have land-line teleprinter connexions to the international meteorological network, and the Conference felt that the time had come to start considering a long-term plan for the whole network which until now has been based largely upon requirements as they developed during the concluding phases of the war. It is hoped that by 1951 it will be possible to install regenerative repeaters wherever they may be necessary, which will enable longer circuits with more links to be used. It may also be possible to work with only three main telecommunication centres in western Europe.

Met. Mag., London, 77, 1948, p. 220.

At an I.C.A.O. North Atlantic Meteorological Telecommunications meeting which was held in London immediately before the Stockholm Conference, it was decided that Paris should be the main European terminal for the exchange of American and European information by radio teleprinter. The I.M.O. Conference at Stockholm decided to accept this recommendation as the basis of the I.M.O. European telecommunications scheme. Plans were therefore made for the re-allocation of areas of responsibility among the four main teleprinter centres so as to allow Paris sufficient time to re-diffuse bulletins originated at New York. Important consequences of the London decision are that the Montreal-Prestwick meteorological W/T channel which was established in 1940 for war-time purposes will cease on December 1, 1949, and on October 1, 1949, the British W/T broadcasts on transmitter GFT will be replaced by a French broadcast designed to relay North American data to those European countries which do not receive this material by teleprinter.

The sub-committee charged with the task of planning the reorganization of W/T broadcasts soon became aware of a general demand for the speedier re-issue of "A" station data by the four "sub-continental" transmitters: Dunstable, Paris, Rome and Moscow There was an almost equally urgent demand for a transmission which would contain only aerological information. It was felt that the increased amount of radio-sonde and upper wind data which have become available since the war make it necessary for a broadcast to be made from one European centre on the same lines as the pre-war broadcast from a German transmitter.

Regarding national W/T broadcasts it was suggested that, in order to affect economy in frequencies and to facilitate the collection of data at the sub-continental centres, broadcasts from some of the smaller countries could be combined and made from one transmitter. The views of those countries which were not represented at the Conference are being obtained.

Both sub-committees were of opinion that an abbreviated system for the heading of meteorological bulletins should be introduced; the abbreviations which have been in use for some time on certain circuits were considered suitable, but it was felt that any such system should not be introduced in any one region before it had been approved for world-wide use by the I.M.O.

In all, 39 recommendations were made, covering such points as teleprinter operational procedure, the exchange of terminal forecasts on the meteorological teleprinter network, the installation of a W/T broadcast transmitter in the Faeroes and the addition of "Block Indicator" numbers at the end of collective messages.

Many European countries, including Great Britain, are interested in the development of facsimile apparatus for the transmission of weather maps. Delegates were able to compare notes on the progress made in the experimental work going on in France, the Netherlands, the United Kingdom and Sweden. A sub-panel was formed to draft a specification for facsimile apparatus which would satisfy the requirements of meteorologists, and decided to adopt, as a working basis, a chart size of 40 cm. × 50 cm. and a definition such that figures 1 mm. high would be clearly legible. It was considered that the "scanning density" would have to be not less than $5\frac{1}{3}$ lines per millimetre, and that the time required for transmission should not exceed 20–25 min.

Delegates were invited to join a Sunday excursion to the Royal Palace at Drottingsholm and to attend a dinner given by the Swedish Ministry of Communications. Both these events gave full evidence of the traditional Swedish hospitality.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Second Conference of I.C.A.O. North Atlantic Ocean Stations, London, 1949

By Cdr. C. E. N. FRANKCOM, O.B.E., R.N.R.

The I.C.A.O. Conference on ocean weather ships, which opened in London on April 20, 1949, was attended by representatives of Belgium, Canada, Denmark, France, Iceland, Ireland, Mexico, Netherlands, Norway, Portugal, Sweden, the United Kingdom, the United States of America and the International Meteorological Organization. Brigadier Booth of Canada was elected Chairman.

The object of the Conference was to consider the ocean weather station plan, which had been originally set up by the 1946 Conference, to see if it would be practicable to reduce the number of stations, and to consider any possible improvements or modifications to the scheme.

One of the most important questions before the Conference was the sharing of financial responsibility amongst the countries concerned. It proved impracticable to assess non-aeronautical benefits and it was finally decided to share the cost on the basis of the number of scheduled flights across the Atlantic of aircraft belonging to each nation.

The possibility of reducing the number of ships on account of the heavy cost in money and manpower was considered, and though the previous number of 13 was regarded as really desirable meteorologically, it was agreed to reduce the number to 10 as the absolute minimum, below which the ships would be too widely spaced.

As a result of the agreed re-allocation of responsibility and of the reduction of stations, the new stations will be operated as follows:—

Station	Position	Governments responsible	Number of vessels	
A	62° 00′N. 33° 00′W.	Netherlands United States	1 2	
B	56° 30′N. 51° 00′W.	Canada United States	1 2	
C	52° 45′N. 35° 30′W.	United States	3	
D.	44° 00′N. 41° 00′W.	United States	2½	
E	35° 00′N. 48° 00′W.	United States	2½	
H	36° 00′N. 70° 00′W.	United States	2	
I	59° 00′N. 19° 00′W.	United Kingdom	2	
J	52° 30′N. 20° 00′W.	United Kingdom	2	Netherlands to perform 7 patrols annually.
K	45° 00′N. 16° 00′W.	France	2	
M	66° 00′N. 02° 00′E.	Norway in co-operation with Sweden, Belgium and Denmark.	2	

It will be noted that the former stations G (U.S.A.) and L (France) disappear, and stations E and F (U.S.A.) are amalgamated into one station E (U.S.A.). France moves from station L to K. Belgium withdraws her ship, which formerly operated at K, from service and becomes a cash contributor instead. Netherlands moves her one ship from K to assist in operating station A (with U.S.A.) and provides another ship for part-time operation at J and K (with U.K. and France). The old and new networks are shown on the map at Fig. 1.

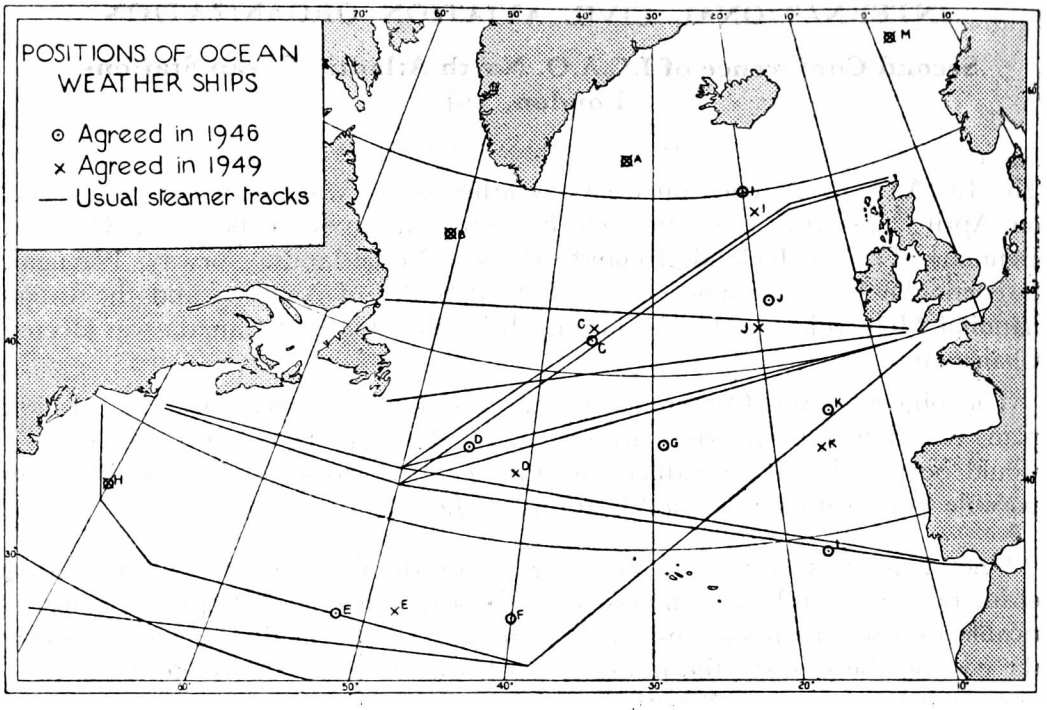

FIG. I—OLD AND NEW OCEAN WEATHER STATIONS IN THE NORTH ATLANTIC

The net result of this Agreement, as far as the United Kingdom is concerned, is that the four British ocean weather ships will continue to operate at the new stations I and J, but that they will be relieved from this duty for five voyages during the year, which will mean a very considerable economy in the matter of fuel, meteorological stores and repairs. Great Britain is also relieved of her responsibility of contributing towards the joint operation of Station M.

No notable changes were made in the functions to be performed by the ships except that those of other countries are to be encouraged to increase the frequency of radio-sonde ascents from two to the four already performed by British ships.

A new Agreement on the organization, to last until June 30, 1952, was signed on May 6, 1949, and will come into force when accepted by the governments responsible for operating not less than eighteen of the ships concerned.

All the delegates at the Conference, though naturally concerned to administer the organization as economically as possible, showed their appreciation of the value of the weather ships as regards both meteorological observations and immediate navigational aid to aircraft.

NOTES ON SYNOPTIC WEATHER ANALYSIS ON THE FRINGE OF ANTARCTICA

By G. DE Q. ROBIN, M.Sc.

Manning the Antarctic bases of the Falkland Islands Dependencies Survey (F.I.D.S.) is a cold and lonely task which was first commenced in January 1944. That year, bases were established at the old whaling-factory site on Deception Island and at Port Lockroy. Gradual expansion of the Survey has taken place since then. Hope Bay (63°24′S. 56°59′W.) was established in 1945 and Cape

Geddes (60°42′S.44°35′W.) and Stonnington Island, Marguerite Bay (68°11′S. 67°01′W.), in 1946. In 1947 the Port Lockroy base was transferred to the site of the 1934–37 British Graham Land Expedition's base in the Argentine Islets, and the South Orkney's base was moved from Cape Geddes to Signy Island (60°43′S. 45°35′W.).

One of the main functions of these bases is the taking and transmission of weather observations throughout the year. Using them in combination with weather reports from South America, Falkland Islands, South Georgia and occasional ship reports, it is now possible to study the weather on this fringe of Antarctica by synoptic charts. This gives a different and most useful approach to antarctic weather studies, compared with past antarctic expeditions whose work has been largely climatological.

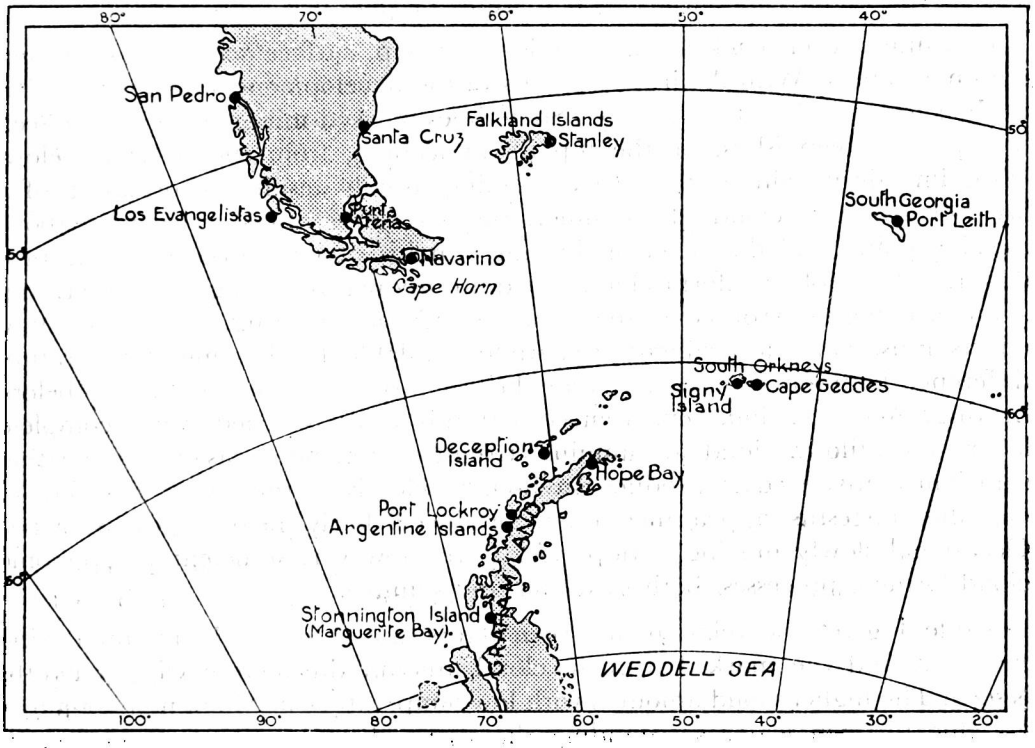

FIG. I—STATIONS IN SOUTH AMERICA AND THE FALKLAND ISLANDS DEPENDENCIES SURVEY

Lamb* employed these (F.I.D.S.) reports in preparing weather maps of the antarctic seas, during the southern summer of 1946–47, for the benefit of ships and aircraft of a whaling company in the Antarctic over 2,000 miles further east. He was able to do this because theories and methods used in northern-hemisphere forecasting were found to apply particularly well in the Southern Ocean. As his work was confined to summer and autumn months, I have thought it worth while to add some notes on the weather systems I noted more particularly during the winter and spring of 1947 at the South Orkneys. Frontal-depression theories are also found to apply extremely well during the winter months as can readily be seen from the instrumental traces reproduced.

*LAMB, H. H.; A meteorologist in the Antarctic. *Met. Mag., London*, **76**, 1947, pp. 231 and 247.

The principal air masses experienced around the edge of the antarctic continent are

Antarctic air (A) being that air mass which has spent some time over the continental and barrier ice of Antarctica.

Polar maritime air (Pm) being the air normally found in the southern half of the westerly wind belt of the southern hemisphere.

A more temperate type of maritime air (Tm) was also occasionally experienced, this air coming from a more northerly portion of the westerly wind belt.

Due to the oceanic situation of the South Orkneys, radiation appears to have only a small effect on weather phenomena. It is thus possible to divide the types of weather experienced there, apart from cyclonic disturbances, into four main groups according to the type of air mass present (A or Pm), and to the underlying surface—open water or pack ice.

In winter, when pack ice surrounds the group, surface cooling has the predominant effect. With A air, this results in the development of inversions close to the surface and a cloudless sky. Sometimes marked mirage effects were seen to separate steep islets, or the top of an iceberg, from the horizon below. With Pm air in winter, the surface cooling usually results in formation of a layer of stratiform cloud. In summer, the sea temperature rarely rises above freezing point, and the effect on Pm air remains similar, surface cooling producing a layer of stratiform cloud, or, quite frequently, of fog. However, any A air reaching the group over the open sea undergoes heating, and the resulting effects must vary according to the time available for heating, temperature difference between sea and air, and the stability conditions in the air before heating. Actually, clouds experienced with this air mass varied from a complete layer of stratiform cloud to cumulus congestus. On no occasion was heating sufficiently advanced to produce anvil-cirrus clouds or thunder, but clouds of cumulus-congestus appearance often produced fairly heavy snow showers. Occasional slowly moving anticyclones were, however, sufficient to overcome cloud-forming processes, both in winter and summer.

Table I gives the relation of screen temperature to cloud amount during the year, and the marked drop in cloud amount during the winter months is seen. The higher cloud amounts with low temperature in May and September are due to open water surrounding the group during part of these months. A more striking result of the above effects was that, during 1947, the largest monthly hours of sunshine were recorded in August (southern winter) and the minimum number in February (southern summer). Arctic sea smoke was observed only once, shortly before the arrival of the pack ice in May. The vapour-pressure difference between sea and air was then 4·5 mb. Local orographic effects were quite frequent, but as they are not of great general interest I shall not discuss them, except to mention that they account satisfactorily for the glaciation of Signy Island, on which our station was situated, being much less than that of the higher and larger Coronation Island just to the north.

In autumn, winter, and spring, sharp frontal surfaces resulting in cyclonic development frequently form between A and Pm air, that is, along the antarctic front. The natural place for such fronts to develop most strongly is along the edge of the pack ice, which in winter runs roughly in an east-north-east direction across the South Atlantic. Cyclones observed in the antarctic front

were either well developed cyclones which approached Graham Land and from the west, or were young cyclones which formed near the northern tip of Graham Land, the latter being more in evidence in late autumn and spring. The direction of travel of these cyclones is roughly eastwards, and appears to depend mainly on the direction and latitude of the pack-ice edge. This construction fits winter synoptic charts much better than the possibly better-known hypothesis, that the cyclonic centres travel south-eastwards towards the semi-permanent Weddell Sea low, in which they are finally absorbed. The speed of travel of both young and old cyclones is around 600 miles per day, a somewhat higher figure than in temperate latitudes. Both types often occur in a train of two or three successive cyclones, and a train of well developed cyclones is generally a forerunner of the injection of a cold air mass over the South American continent. These air masses are then protected on the west by the Andes, and travel northwards as far as Brazil with typical cold-front weather.

TABLE I—RELATION OF TEMPERATURE TO CLOUD AMOUNT, SOUTH ORKNEYS, 1947

Station and period	Temperature ranges									
	less than 0 °F		0–10°F.		10–20°F.		20–30°F.		over 30°F.	
	No. of obs.	Mean cloud	No. of obs.	Mean cloud	No. of obs.	Mean cloud	No. of obs.	Mean cloud	No. of obs.	Mean cloud
		tenths		tenths		tenths		tenths		tenths
Cape Geddes										
January 10–31 ..	..	..	..	..	..	..	26	9·0	39	9·2
February ..	..	..	..	..	..	..	18	9·5	66	9·9
March 1–14 ..	..	..	..	..	..	..	6	10·0	33	8·8
Signy Island										
March 22–31 ..	..	..	..	..	..	..	6	9·1	22	8·1
April	..	..	..	..	3	10	35	9·3	54	8·2
May	8	8·4	8	8·4	23	8·0	40	8·9	11	9·0
June	11	5·3	25	7·2	20	8·1	26	9·2	9	10
July	27	3·2	12	5·2	12	6·5	17	8·9	25	9·2
August	13	3·0	22	5·6	6	4·0	31	7·7	21	8·8
September ..	3	6·7	4	7·2	15	9·5	35	8·6	33	8·7
October ..	..	..	..	..	11	9·0	30	8·1	52	8·1
November ..	..	..	..	..	..	..	22	8·5	68	9·4
December ..	..	..	..	..	..	..	60	9·2	33	9·1
Total ..	62	4·4	71	6·5	90	8·0	350	8·8	485	8·9

Figs. 2–8 illustrate a well developed antarctic-front cyclone in August 1947 which, combined with the situation of the subtropical anticyclone well south over South America, caused one of the famous winter gales " south of the Horn ", with a pressure gradient of 50 mb. in 700 miles. This was followed by two similar well developed cyclones, after which a cold air mass started to cover South America.

Figs. 9–13 of June 1947 show the development of a cyclone in the antarctic front off the northern end of Graham Land, and its progress in an east-north-east direction beyond South Georgia. The instrumental traces, for this period, at the South Orkneys show the great clarity of the fronts, and are typical of the simplicity of many weather phenomena of the southern oceans.

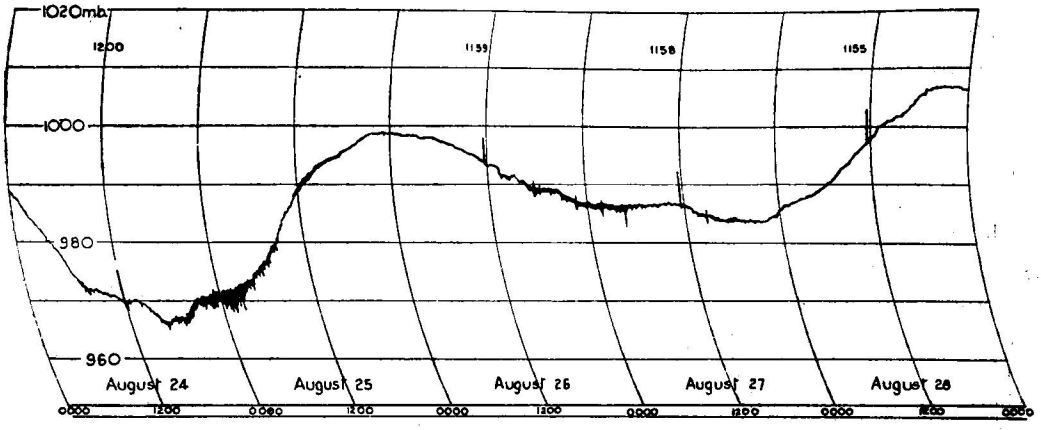

FIG. 2—TRACES FROM BAROGRAMS AT SIGNY ISLAND, AUGUST 1947
The broadening of the trace is due to a suction effect in high winds

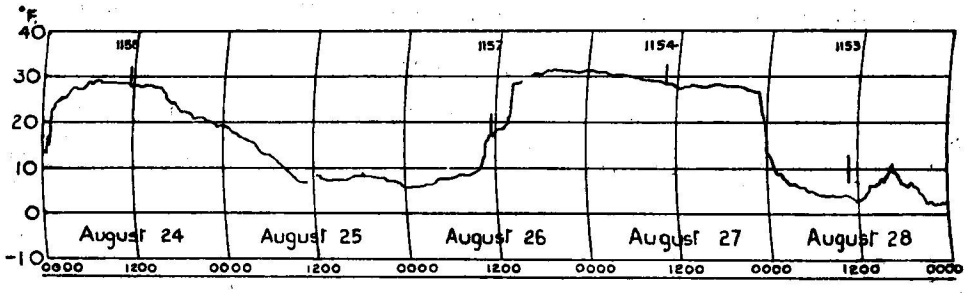

FIG. 3—TRACES FROM THERMOGRAMS AT SIGNY ISLAND, AUGUST 1947
The breaks in the trace are due to instrumental failures

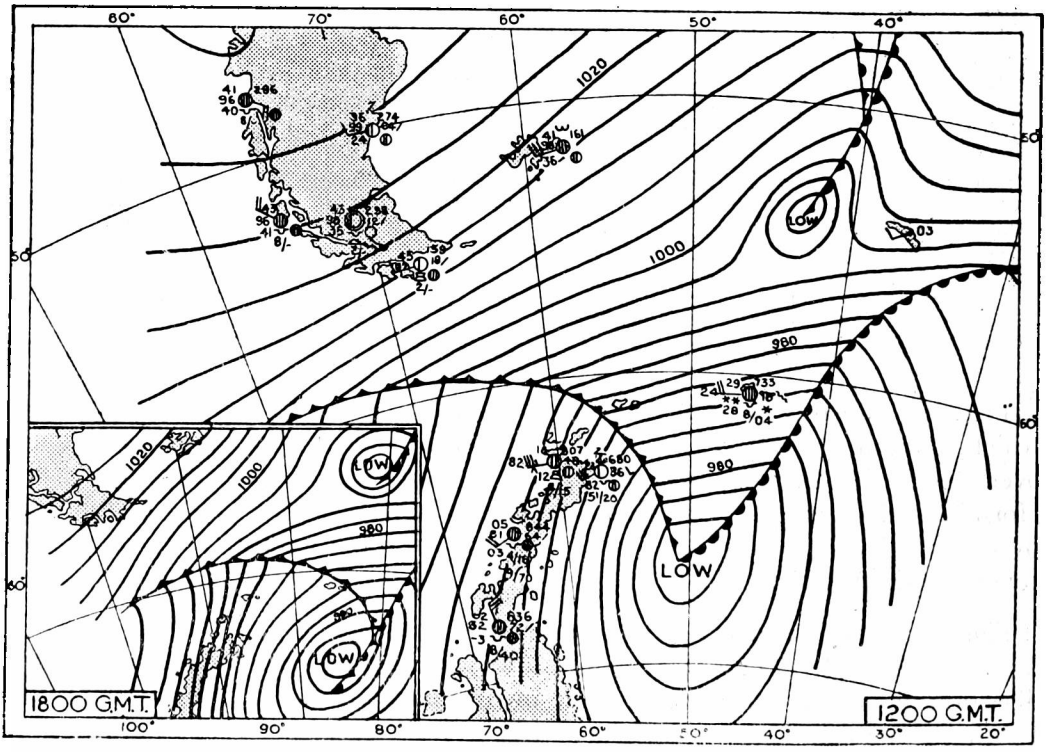

FIG. 4—SYNOPTIC CHARTS, SOUTH ATLANTIC, AUGUST 24, 1947

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METEOROLOGICAL STATION AT SIGNY ISLAND, SOUTH ORKNEYS

The local harbour, Borge Bay, fills the centre of the picture and Coronation Island is in the background

OROGRAPHIC CLOUD COVERING CORONATION ISLAND

Photograph taken from the south during a northerly wind

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Reproduced by courtesy of Mrs. G. A. Clarke

MR. G. A. CLARKE

Mr. G. A. Clarke, who was well known for his cloud photographs, died on February 13, 1949. An obituary notice appeared in the May issue of this Magazine

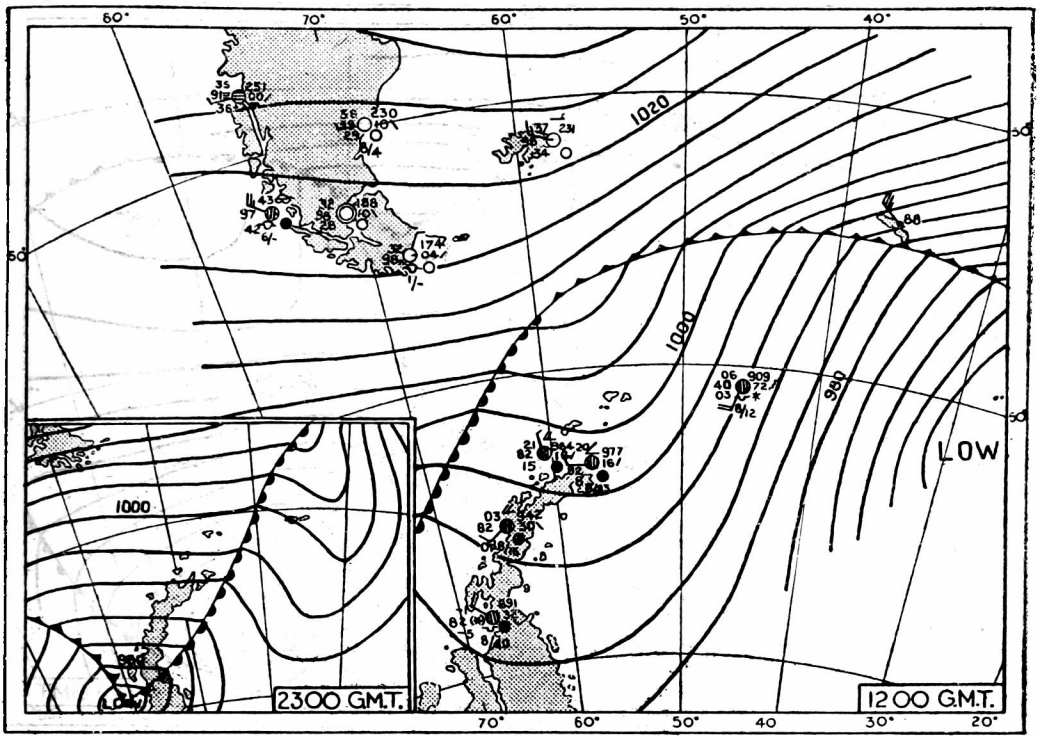

FIG. 5—SYNOPTIC CHARTS, SOUTH ATLANTIC, AUGUST 25, 1947

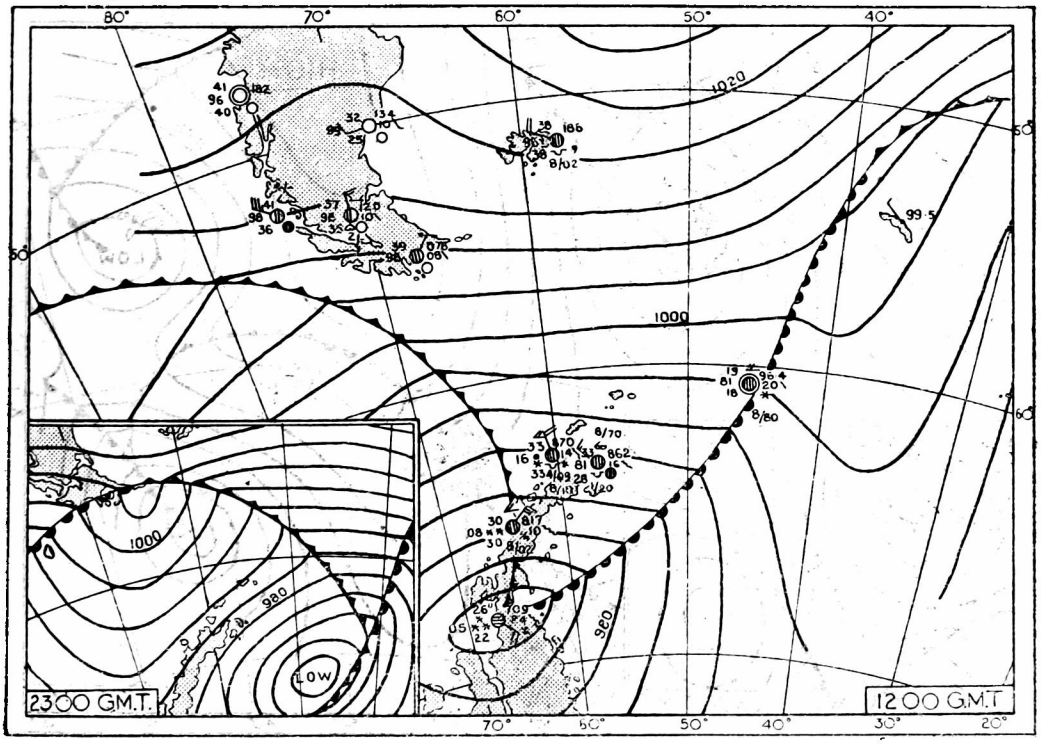

FIG. 6—SYNOPTIC CHARTS, SOUTH ATLANTIC, AUGUST 26, 1947

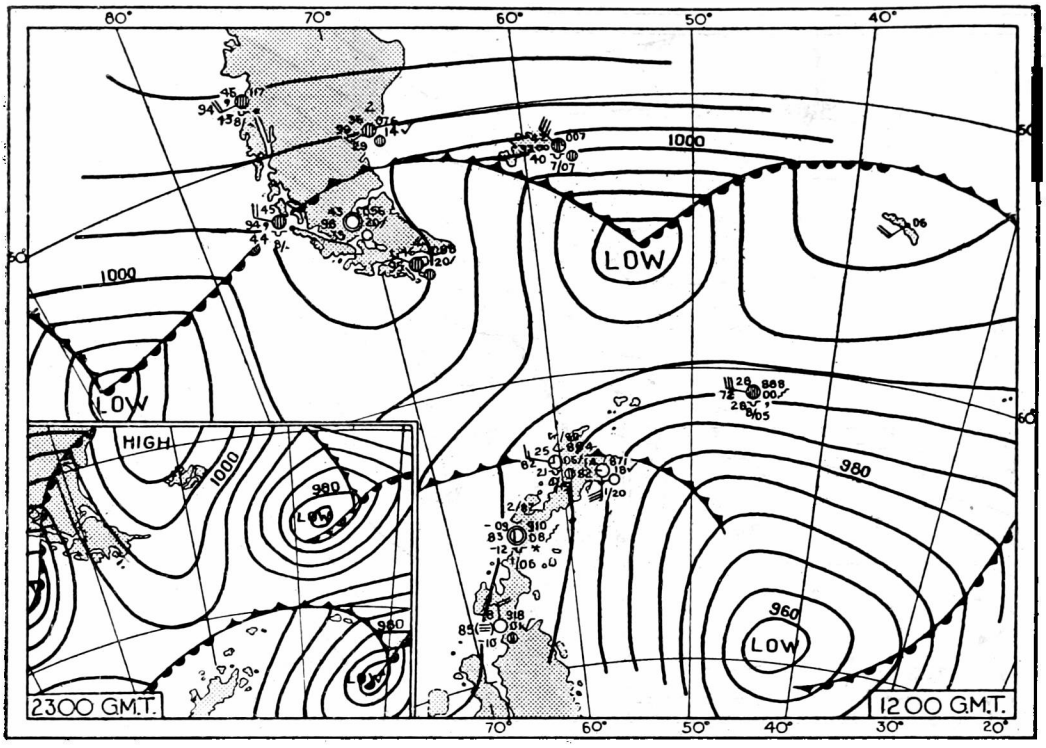

FIG. 7—SYNOPTIC CHARTS, SOUTH ATLANTIC, AUGUST 27, 1947

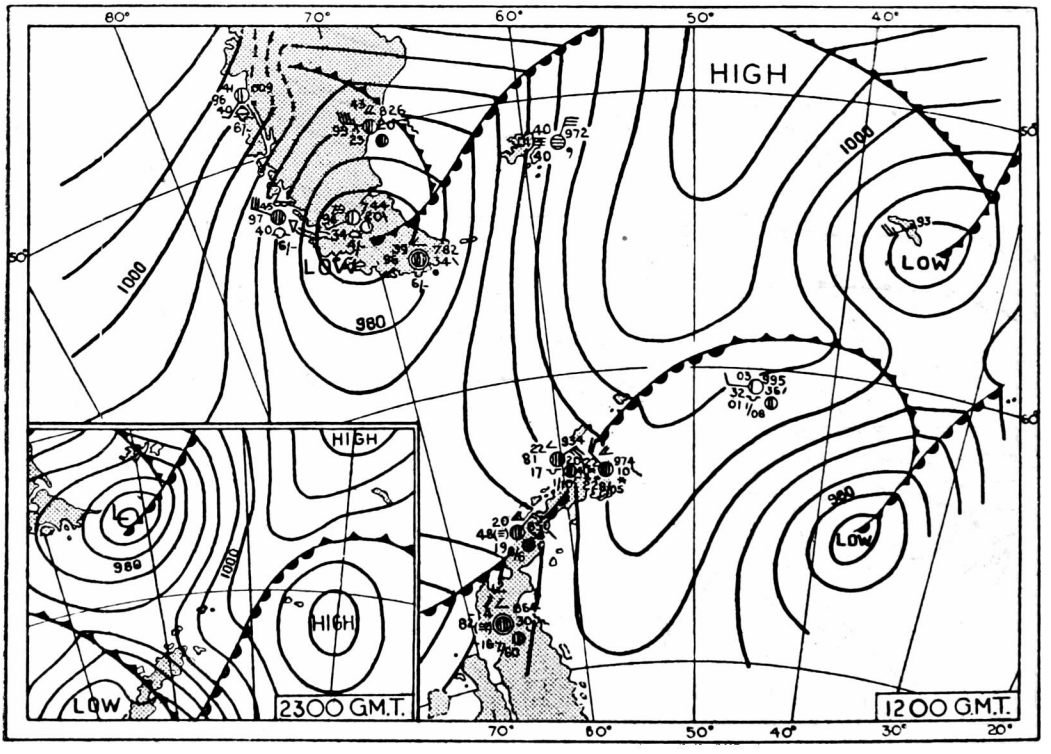

FIG. 8—SYNOPTIC CHARTS, SOUTH ATLANTIC, AUGUST 28, 1947

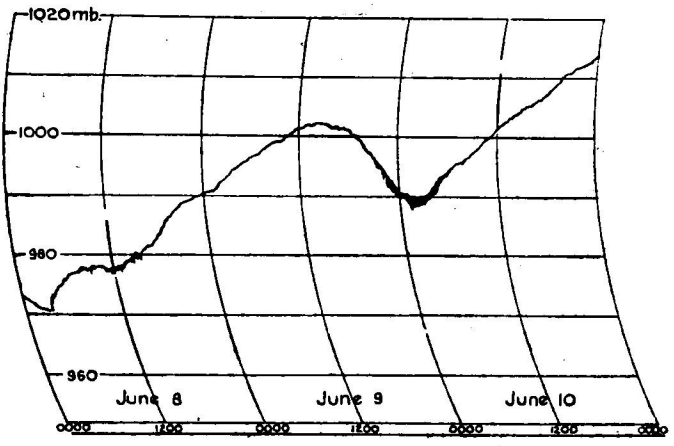

FIG. 9—TRACES FROM BAROGRAMS AT SIGNY ISLAND, JUNE 1947

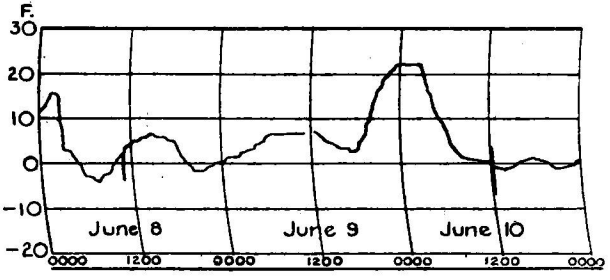

FIG. 10—TRACES FROM THERMOGRAMS AT SIGNY ISLAND, JUNE 1947

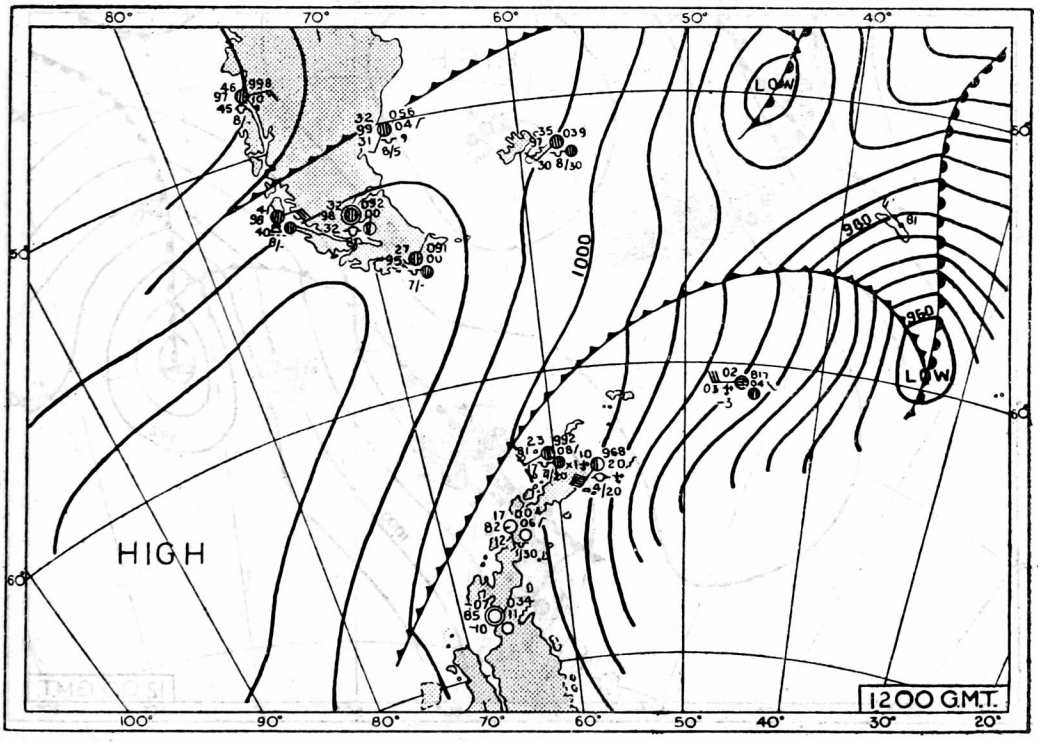

FIG. 11—SYNOPTIC CHART, SOUTH ATLANTIC, JUNE 8, 1947

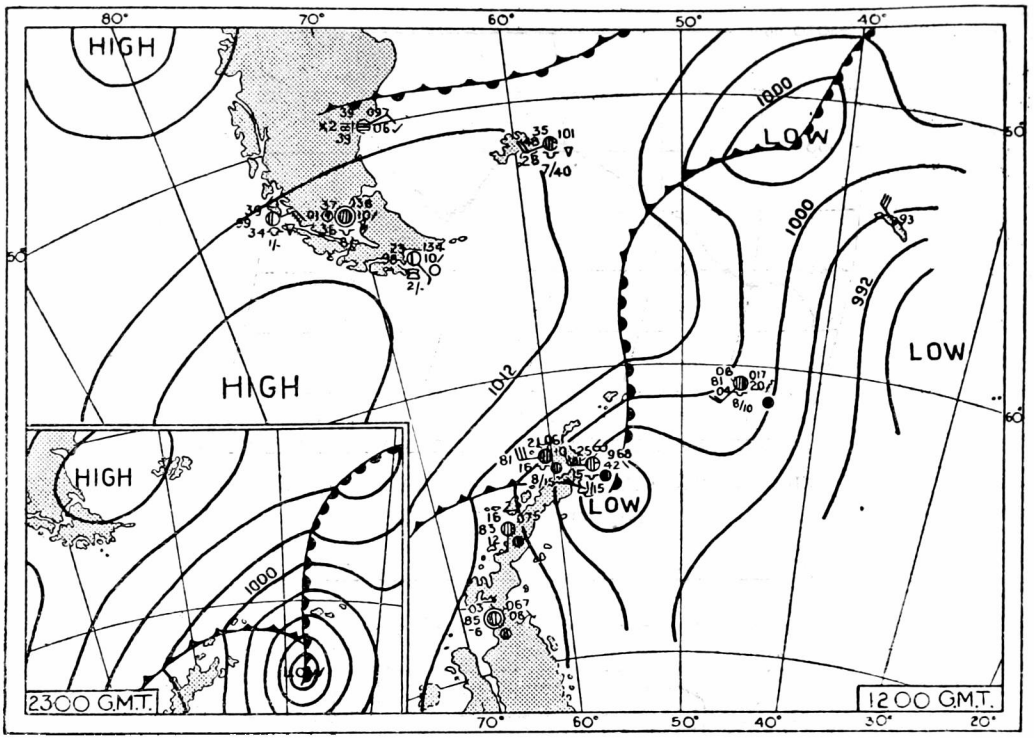

FIG. 12—SYNOPTIC CHARTS, SOUTH ATLANTIC, JUNE 9, 1947

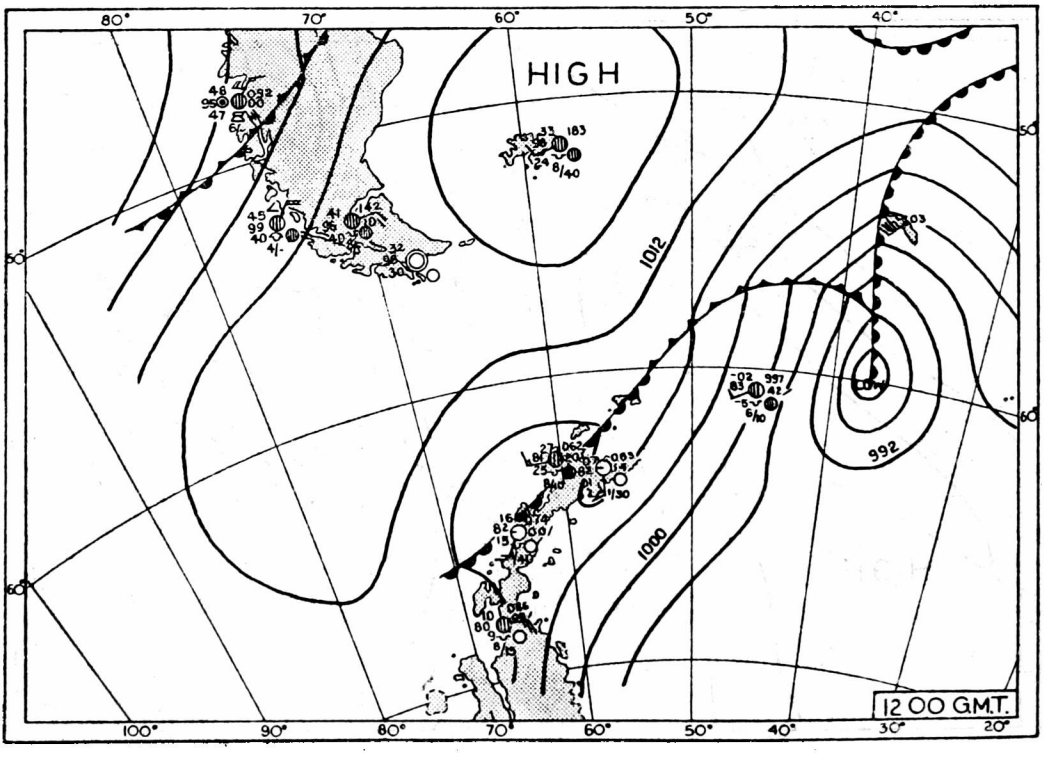

FIG. 13—SYNOPTIC CHART, SOUTH ATLANTIC, JUNE 10, 1947

Charts for November 24–25 show a third type of cyclone, experienced in 1947 in October and November, in which the cyclone forms on a meridional front passing Cape Horn. This carries air (Tm) much warmer than normal

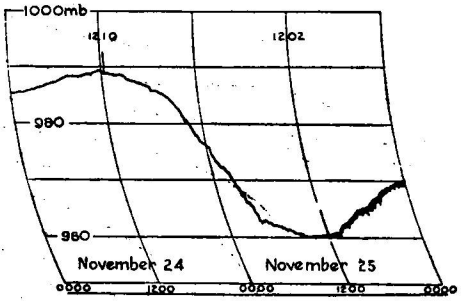

FIG. 14—TRACES FROM BAROGRAMS AT SIGNY ISLAND, NOVEMBER 1947

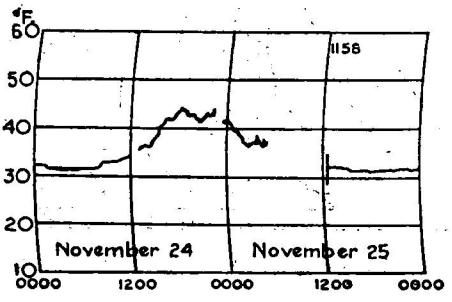

FIG. 15—TRACES FROM THERMOGRAMS AT SIGNY ISLAND, NOVEMBER 1947
The breaks in the trace are due to instrumental failures

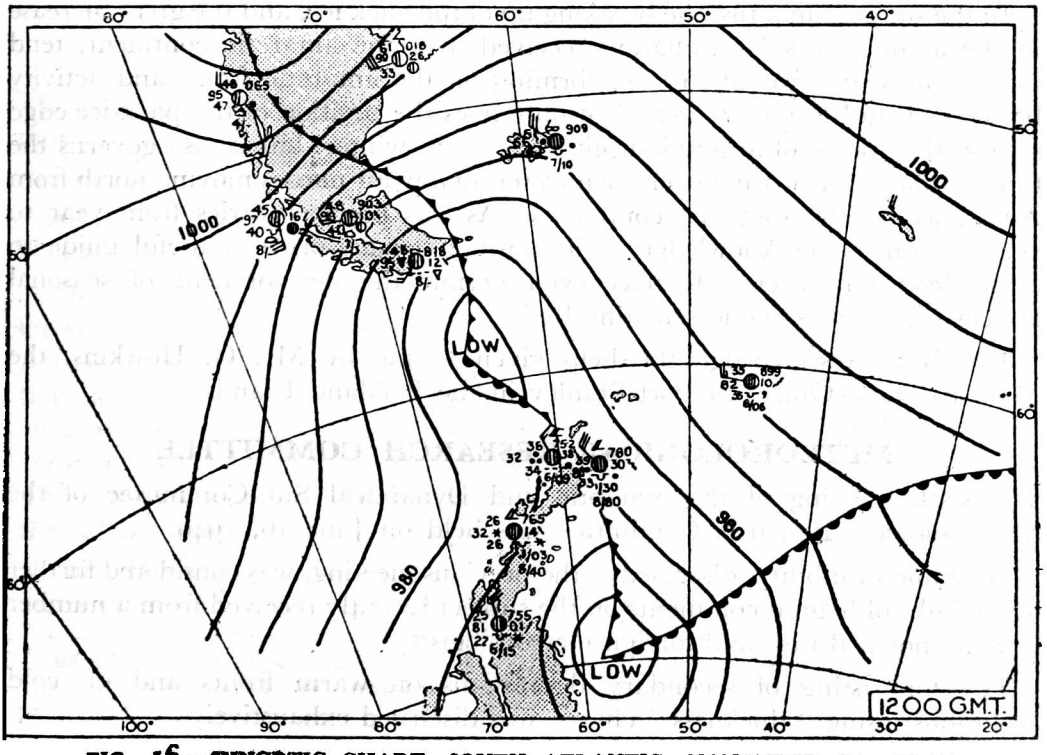

FIG. 16—SYNOPTIC CHART, SOUTH ATLANTIC, NOVEMBER 24, 1947

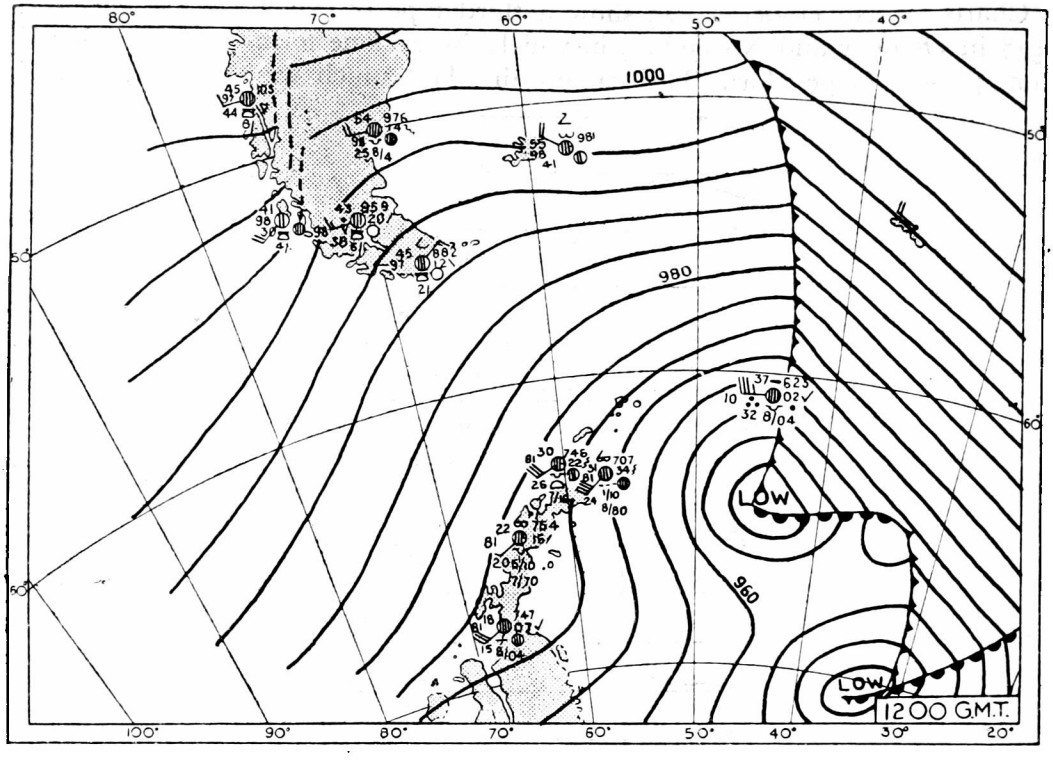

FIG. 17—SYNOPTIC CHART, SOUTH ATLANTIC, NOVEMBER 25, 1947

over the South Orkneys; and on Signy Island temperatures as high as 50°F. (although not on this occasion) were recorded due to orographic effect, plus breaking up of a surface inversion by the much higher Coronation Island to the north.

In the summer months, the breaking up of the pack ice, and the great increase in the amount of solar radiation received over the antarctic continent, tend to prevent sharp frontal surfaces forming on the antarctic front, and activity between A and Pm air ceases. Not only does the position of the pack-ice edge govern the course of antarctic-front cyclones in winter, but it also governs the time available for heating over open water, of any air masses moving north from Antarctica to the southern continents. As this position varies from year to year, a continuous knowledge of its position would prove a useful guide to antipodean forecasters. It may even permit the development of seasonal forecasts on a reasonable scientific basis.

I wish to acknowledge the help given to me by Mr. G. Howkins, the Meteorological Officer at Port Stanley in the Falkland Islands.

METEOROLOGICAL RESEARCH COMMITTEE

The sixth meeting of the Synoptic and Dynamical Sub-Committee of the Meteorological Research Committee was held on June 16, 1949.

Dynamic instability, discussed at the previous meeting, was considered further in the light of helpful comments on the subject recently received from a number of well known British and foreign meteorologists.

The forecasting of secondary depressions on warm fronts and on cold occlusions, using " thickness " charts, was discussed exhaustively.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:—

Weather on the west coast of tropical Africa from 20°N. to 20°S. including the Atlantic Ocean to 25°W.

This handbook has been prepared primarily for the use of Meteorological Officers on H.M. Ships, and it summarises the available statistical and descriptive material on the weather on the west African coast between 20°N. and 20°S., and over the Atlantic Ocean to 25°W. It is intended to provide these officers with a general description of the climates of the region and of local variations within the climates.

In the early part of the volume the general climatic features of the whole region are described and there are also more detailed climatic summaries for smaller areas. The remainder of the text deals with each of the meteorological elements in turn, giving mean and extreme values; local notes and notes on forecasting are included wherever possible. The text is illustrated by 71 maps and diagrams, and an appendix contains many statistical tables and a bibliography. (M.O.492, Price: 5*s.* 0*d.*)

Meteorology of airfields, by C. S. Durst, B.A.

" Meteorology of airfields " is written primarily to supply the designers of airfields with the type of data they need, and to show in what way meteorological data can be used for their purposes. The book deals in succession with visibility, cloud, flying-fitness figures, precipitation, wind, pressure and temperature; in each case the frequencies of occurrence are related to physical causes in an endeavour to show how the principles learnt in one region may be applied and modified to suit another. The examples chosen embrace many countries, principally those which were the scene of operations during the late war. As an appendix, tables are included of the frequencies of poor visibility and low cloud height at many of the principal airfields of the world.

(M.O.507, Price: 2*s.* 0*d.*)

The following publications will be published within the next six to nine months:—

GEOPHYSICAL MEMOIRS

No. 85—*Upper winds over the world.* By C. E. P. Brooks, C. S. Durst, N. Carruthers, D. Dewar and J. S. Sawyer.

The problem attacked is to construct roses of wind speed and direction for any place on the earth's surface at any height above sea level up to 40,000 ft. Actual observations are quite insufficient for this purpose, but it was found* that in the free air the distribution of the winds approximates to the normal circular distribution about the vector mean wind. Hence a wind rose can be constructed if the vector mean wind and standard vector deviation are known. The evidence for this is recapitulated in Part I and tables are given to facilitate the calculations.

Outside the tropics the vector mean wind can be calculated from the distance apart of lines of equal height of the isobaric surfaces, and Part II of the memoir

*BROOKS, C. E. P., DURST, C. S. AND CARRUTHERS, N.; Upper winds over the world. Part I. The frequency distribution of winds at a point in the free air. *Quart. J. R. met. Soc., London*, **72**, 1946, p. 55.

gives world charts on Mercator's projection of the mean heights of the isobaric surfaces of 700, 500, 300, 200 and 130 mb. for the four seasons December to February, March to May, June to August and September to November, with an account of the method of construction.

Part III gives charts of the mean standard vector deviation for the same levels and seasons. These were made possible by the discovery that nearly up to the level of the tropopause the product of the standard vector deviation with the air density is in most cases constant for any one place and season. For much of the world the values had to be extrapolated from known regions, and the method of doing this is described.

Between latitudes 25°N. and S. the geostrophic relation between pressure gradient and wind does not hold, and for these regions seasonal charts of stream-lines and mean vector speed of the wind were constructed up to the level of 200 mb.; for 130 mb. the data were insufficient.

No. 86—*Solar radiation at Kew Observatory.* By J. M. Stagg, M.A., D.Sc.

The following paragraphs give a brief advance abstract of this forthcoming *Geophysical Memoir.*

The continuous records of direct solar radiation at normal incidence maintained at Kew since 1932 are discussed in the first half of the paper, and the measurements of total short-wave radiation on a horizontal surface from sun and sky together, and sun alone, made since 1946, are dealt with in the second part.

Both parts open with a description of the instruments and their standardization. Statistical treatment of the records follows with monthly and annual totals for all days and daily totals and extreme values for selected days of clear sky and high radiation. A particularly interesting feature is a tabulation of the three components of the incoming solar radiation for clear days computed from hourly values of the normal radiation and from the sun's altitude and azimuth. The variation of incoming radiation with time of day, solar altitude and mass of air traversed by the beam (" air mass " in the radiation sense) are tabulated and discussed. Transmission coefficients and turbidity factors are computed. A comparison is given between diffuse short-wave radiation from clear and cloudy skies and, finally, there is a discussion of the average relation between total and diffuse sky radiation for the four seasons. A detailed discussion of the physics of all topics dealt with is provided.

ROYAL METEOROLOGICAL SOCIETY

General circulation of the atmosphere

At the meeting of the Society on May 18, with Mr. E. Gold, F.R.S., Vice-President, in the Chair, a discussion was held on the general circulation of the atmosphere.

The discussion was opened by Dr. E. T. Eady, who described his recent researches on the dynamics of atmospheric waves and the transfer of heat from equator to pole and from the lower to the upper atmosphere. He pointed out that the earth's surface polewards of latitude 35° and the upper atmosphere everywhere lost heat by radiation on the whole, and the earth's surface equatorwards of 35° gained heat by radiation, so that a mechanism was needed

to allow of the transport of heat to the regions losing it by radiation from those which gain it, and also to provide the transference of momentum, without which the earth's atmosphere would soon be brought to relative rest by skin friction. The necessary transfer of heat and momentum was carried out by atmospheric eddies which arise as a result of the dynamic instability of any steady baroclinic motion. Dr. Eady said that, in a paper to be published shortly in the new Swedish journal *Tellus*, he had shown, from the equations of motion and realistic boundary conditions, the existence of two dominant types of atmospheric eddies. One of these had a long wave-length such that there might be six associated troughs around the northern hemisphere and the other had a short wave-length and corresponded to the so-called wave depressions. The transport of heat by the eddies was included in his paper but he had not been able to calculate the momentum transport for any realistic system. There was an essential difficulty in the calculation of the flow of momentum in that the momentum of an air particle or of any associated quantity such as angular momentum, vorticity, etc., was not conserved to even a limited extent as the particle moved.

Dr. Forsdyke then described the work of Priestley on heat transport and zonal stress between latitudes, published in the Society's *Quarterly Journal**. Priestley calculated the meridional flux of heat, water vapour, and momentum for two years at Larkhill. An adequate treatment of the problem would involve computations based on a number of stations well distributed round a given parallel of latitude; the present work, limited as it was to one station, was intended only to indicate the possibilities and method of such computations. The flux of heat was evaluated for both sensible (proportional to $c_p T$) and latent heat The flux was separated into a steady advective flux and an eddy flux. As regards heat it was verified that the atmospheric eddy flux is of the magnitude required to equalise the heat gains and losses by radiation, while for momentum it was confirmed that the zonal stress arising from deep meridional currents can maintain wide zonal circulations against friction. The eddy flux of sensible heat is northwards in the lowest layers at all seasons, but is reversed at all seasons at a variable level in the middle or upper troposphere. There is no corresponding reversal in sign of the mean horizontal temperature gradient at this level. The flux of latent heat is northwards at all significant levels and is negligible above 400 mb.

Dr. R. C. Sutcliffe gave a contribution on the synoptic aspect of the general circulation. It had been shown, by Brunt and others, that under reasonable assumptions the kinetic energy of the atmosphere would be dissipated by friction in 5 or 6 days. This suggested to him that the atmosphere balanced its books every week or so, and that the relatively short-period types or " modes " of the circulation pattern which often lasted for weeks had as much right to be called the general circulation as had an average over many years, which was never, in fact, realised at any one time. Dr. Sutcliffe showed slides illustrating a number of these patterns, including (*a*) the meridional pattern with a preponderance of wind along the meridians in both directions, (*b*) the double-structure pattern with a ring of depressions in the far north, a ring of anticyclones in middle latitudes and then a further ring of depressions towards the subtropics, (*c*) the summer monsoon type of low pressure over the continents,

*PRIESTLEY, C. H. B.: Heat transport and zonal stress between latitudes. *Quart. J. R. met. Soc., London*, 75, 1949, p. 28.

and finally (*d*) the inverted winter monsoon type with high pressures in the north of the hemisphere and low pressures in the south which was so persistent in February 1947.

In the general discussion which followed, Professor Sheppard said the stratosphere seemed to have been neglected and pointed out that though the density was small, yet the measured winds were so high that they gave a large mass transport, Mr. Brewer referred to the difficulties of explaining the chemical constitution of stratospheric air which had such a low relative humidity over England that it seemed the air must have come northwards from the subtropical stratosphere, and Mr. Sawyer suggested that it would be more useful to study one of the other thermodynamic parameters rather than the heat transport as computed by Mr. Priestley; the transport of internal energy or total heat might prove more satisfactory.

ROYAL INSTITUTE OF BRITISH ARCHITECTS

Professor Gordon Manley gave an Architectural Science Board lecture at the Royal Institute of British Architects on April 12, 1949. The lecture was entitled " Microclimatology: Local variations of climate likely to affect the design and siting of buildings ".

Professor Manley opened his lecture by suggesting that microclimatology is largely the geographer's problem as it is concerned mainly with assembling and interpreting existing data. In applying results from microclimatology, architects may have to use the technique of botanists; they must certainly ensure that any exotic forms of architecture should be suitable not only for the weather usually experienced, but also for the extremes which occasionally occur.

The incidence of frost varies widely over comparatively small distances, because of topographical effects. These effects exert most influence on radiation nights, which occur as frequently as two nights out of five. In Worcestershire, for example, it is more frosty at Perdiswell (in fairly level farmland) than on the sloping land of Malvern; at Droitwich, where the climatological station is well down on the Severn plain, it is frostier still. Professor Manley pointed out the importance of applying frost data only to areas near the screen and not, necessarily, to a whole town. The effect of soil on frost can be illustrated from Lynford, where the soil is sandy, and Cambridge, on a clay loam. On the coldest nights in each month, Lynford is on the average about 6°F. colder than Cambridge. Generalising, it can be said that the frost-free season is only about two months on extensive sandy lowlands, and as long as seven months in urban sites. The extreme summer temperatures with which British architects must reckon are about 90°F. in the north and 100°F. in the south; the extreme winter temperatures are around 0°F. in the south-west, −10°F. in the Midlands and −20°F. in Scotland. Penetration of frost is clearly important, and in 1895 this was 3 ft. or more. Some frost penetration must be expected even in the West Country, because of the lack of snow cover.

Architects will naturally be concerned to avoid very foggy areas and Professor Manley quoted a number of examples of the drift of industrial smoke, in the Midland Valley of Scotland, along the Great North Road between Doncaster and Wetherby, and in Snowdonia, where the smoke drifts from Lancashire when there is a NE. wind up to some 2,500 ft. At Leicester, smoke on the lee side cuts down the ultra-violet radiation received.

Shelter from strong winds is necessary to prevent undue heat loss, but careful judgment is necessary to avoid frost areas, which are usually in sheltered spots. Land and sea breezes are usually not very important to architects, unless they carry smoke with them. The helm wind is an example of a local wind which has had some influence on local architecture; the strong NE. wind blows down Cross Fell, and few doors are built on this side of farm houses; some shelter is also obtained from trees to the north-east of the houses.

For snow fall and snow lying, the average frequency can be obtained from published maps. Professor Manley suggested that, for inhabited levels, if n is the average frequency of snow lying, the maximum number of days with snow lying likely to be experienced in any year is about $n + 50$. There are few places in this country where the record depth of snow is less than 2 ft., and heavy falls and drifting over roads can paralyse traffic at times. Drifting could be lessened by avoiding wind-swept areas when building roads, and by the careful planting of belts of trees a little distance from the roads.

Finally, Professor Manley dealt with the modification of local climates by buildings; the reduction of wind speed and the increase in minimum temperature are important to architects. On still, clear nights the centre of Manchester is some 10°F. warmer than the surrounding countryside in the summer, and 6–7°F. warmer in winter.

The discussion was then opened by Dr. Glasspoole, who said that architects should have some idea of what the meteorologist aims at recording for each element, and of the work involved in summarising the data. For example, 200,000 computations are necessary to obtain the mean wind speed and direction over 10 years from a Dines' anemometer. Rainfall is the element for which we have the most complete picture, and average rainfall maps were being published by the Ordnance Survey on a scale of 10 miles to the inch. Intense rainfall is important to architects; this is very local, and many more records would be needed before we could improve on our present knowledge of its distribution.

Miss Frisby stated that she had worked with architects and had come to the conclusion that the climatologist was expected to be a jack of all trades. In general, the climatic information which was required by the architect was not available and had to be inferred from what was available. Even then, architects preferred that it should be presented not in meteorological terms but in recommendations as to the type of heating or construction which should be used.

Dr. Brooks expressed the view that smoke was one of the most potent climatological elements in this country, and said that London smoke could be traced as far as Norwich.

Mr. Hibberd was critical of the organization of the consultation between architects and meteorologists, and said that meteorologists had not been consulted until eighteen months after the sites had been chosen for some new towns. He thought that sound was important in deciding where to live and that it should be studied by microclimatologists.

Mr. Robinson pointed out some ways in which climate affects domestic architecture. In Lancashire, dormer windows are less popular than in the south because they tend to let in rain; also 9-in. walls are much more common in London than in the north.

Mr. Hogg said that the lecture had dealt with problems which were also important in agricultural meteorology. He gave an example to show the effect of sloping ground on the incidence of the sun's rays and said that the Meteorological Office intended to co-operate with agricultural colleges in studying the microclimates on various slopes and aspects. He pointed out that it was important for architects to appreciate that the warmest slopes often face somewhat west of south, and not due south.

Mr. Oddie dealt with the problems of the lay-out of towns and estates, and was critical of some modern estates. He said that Le Play believed that the lay-out of mediæval towns was the result of an instinctive knowledge of the local variations of climate. In those times, the builders knew intimately the neighbourhood in which they were working, but today this is by no means always so.

The Chairman agreed with this last point and the meeting accorded its thanks to Professor Manley.

LETTER TO THE EDITOR

Formation of rain

In connexion with the problem of rain from non-freezing clouds it is of some interest to point out the similarity of conditions in which this phenomenon has been reported. Some past published observations have been given in the papers quoted below and a number of new ones will be described by E. J. Smith in a forthcoming publication. All the reports agree in showing rain as occurring

(*a*) in maritime or coastal districts,

(*b*) in tropical or subtropical regions,

(*c*) where the cloud type is reported it is stratified or only moderately turbulent.

In moderate climates, warm-sector drizzle is observed in tropical maritime air, *i.e.* under somewhat similar conditions. No rain proper from non-freezing clouds appears to have been reported and documented from any place more than fifty miles inland although thick clouds which do not reach freezing level are frequent in the summer of Europe, Australia and, presumably, America.

It is possible that in maritime situations, sea spray provides a few and relatively large condensation nuclei which are able to attract all the available water vapour. In this connexion it is of interest that the minimum number of condensation nuclei was observed over the ocean. Inland, the salt nuclei may divide and other nuclei become more numerous.

A theoretical discussion which is to be published in a forthcoming issue of the *Australian Journal of Scientific Research* shows further that a great heat content and very slow cooling are conducive to the formation of few and relatively large drops which in turn may have some bearing on the points (*b*) and (*c*) above.

E. B. KRAUS

C.S.I.R. Radiophysics Division, Sidney, N.S.W., June 9, 1949

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NOTES AND NEWS

Anomalous radar propagation over land in the period November 29 to December 1, 1948

Towards the end of the extensive foggy period which persisted over most of England in the latter part of November 1948, unusually long ranges on permanent echoes were obtained at the 10-cm. radar station at East Hill, near Dunstable. The equipment was only available at intervals in the period from November 29 to December 1, but echoes were received frequently from high ground at ranges up to 145 miles (the maximum range which could be measured with the equipment). The normal range from which ground echoes are received is only 10–15 miles so that it is of interest to examine the meteorological conditions which gave rise to this anomalous propagation.

It is well known that the meteorological factors necessary to give sufficient bending of the radio rays to cause unusually long ranges to be observed are the existence of a temperature inversion of sufficient magnitude or a sufficiently great humidity lapse or a combination of both. The critical condition for temperature effect alone is an inversion of about 1°F. in 17 ft. and for the water-vapour effect alone a lapse of water-vapour pressure of 1 mb. in 100 ft.*

During the morning of the 29th permanent echoes were seen on many bearings at ranges up to 145 miles. The " Balthum " kite-balloon temperature and humidity ascent at Cardington for 0730 G.M.T. on that morning showed an inversion of temperature, commencing at 500 ft., which (according to the readings of the Downham Market radio-sonde) extended to 2260 ft. The total temperature inversion was 23·6°F. of which 15·2°F. occurred in the first 200 ft., *i.e.* from 500 to 700 ft. The temperature inversion therefore was sufficient between 500 and 700 ft. to give super-refraction but in the same interval of height the vapour pressure increased from 5·2 mb. to 7·2 mb. and therefore acted against the temperature inversion, and it can be shown that the increase of vapour pressure completely nullified the effect of the temperature inversion. By 1200 G.M.T., however, although the magnitude of the inversion in the 500–700-ft. layer had decreased to 10·2°F. the vapour pressure had also changed considerably and now decreased from a value of 5·3 mb. at 500 ft. to 2·5 mb. at 700 ft. giving a lapse of vapour pressure in excess of that necessary for super-refraction. On November 29, therefore, it seems likely that the abnormal radar ranges obtained were due to the development between 0730 and 1200 G.M.T. of a super-refracting layer between 500 and 700 ft. Any obstruction, such as high ground, which protruded into this layer would be expected to give a much greater than normal radar echo. The existence of such echoes to ranges of 145 miles at least indicates that the super-refracting layer was continuous over a wide area. It is of interest to note, however, that all the radio-sonde ascents for that day at Larkhill and Downham Market failed to indicate low vapour pressures at

*APPLETON, SIR EDWARD; The influence of tropospheric conditions in ultra-short-wave propagation. Meteorological factors in radio-wave propagation. London, 1947.

800 ft., the dry air being in all cases above this level. This suggests that the dry air extended down to the 700-ft. level only for a period between 0900 and 1500 G.M.T. (the times of the radio-sonde ascents).

On the 30th, abnormal ranges were again observed, but according to the " Balthum " ascents for that day, there was no layer below 1,000 ft. in which super-refraction was possible. The Downham Market 0900 radio-sonde ascent, as published in the *Daily Weather Report*, does not indicate any possibility of a super-refracting layer but somewhat greater detail obtained from the working sheet showed that the vapour pressure fell to 1·3 mb. at 2,050 ft. while the Cardington ascent for 0730 showed the vapour pressure to be 7·4 mb. at least as high as 1,000 ft. In the layer from 1,000 to 2,000 ft., therefore, there was a vapour pressure decrease of 6·1 mb. and, in view of the abnormal ranges observed, the probability is that this decrease took place in a layer of 600 ft. or less.

On December 1 ranges up to 134 miles were obtained between 1100 and 1300 G.M.T. on bearings between north-west and south-east through north, but none on any other bearings. After 1300 all the abnormal echoes disappeared and this coincided with, or was soon followed by, the final dissipation of the fog. Once again the " Balthum " ascents showed no possibility of a super-refracting layer below 1,000 ft. but, in conjunction with the Downham Market ascent for 0900, indicated the probability of a vapour-pressure lapse of about 4·6 mb. between 1,000 and 1,800 ft. There was probably a super-refracting layer within the 1,000–1,800-ft. layer which was destroyed after about 1300 G.M.T. due to the spreading out of the vapour pressure lapse through too great an interval of height by turbulent mixing. (The wind at 2,000 ft. was 23 kt. compared with less than 10 kt. on the previous days examined.)

It is clear that the abnormal ranges observed during this period were associated with a rapid lapse of humidity above the fog but the radio-sonde ascents as published do not give a sufficiently precise definition of the boundaries of the dry layers. The rate of ascent of the balloon (about 1,200 ft./min.) and time lag in the humidity element are probably mostly responsible but it clear that (to the radio man) significant humidity changes are not specially reported in the same way as the temperature inversions.

R. F. JONES

Meteorology in 1815

In the first two decades of the nineteenth century important strides were made in the science of meteorology. Dalton's work on partial pressures, Luke Howard's classification of cloud types and theory of cloud formation by condensation of water vapour in rising currents of air, and the first rough observations of upper winds with pilot balloons belong to this period.

One of the leading meteorologists of the day, T. Forster, F.L.S., wrote a text-book surveying the meteorological knowledge of his time called " Researches about atmospheric phenomena " of which the first edition was published in 1812, the second in 1815 and the third in 1823.

These notes on meteorology in 1815 are prompted by the purchase for a small sum of a very sound copy of the second edition which has now been placed in the Meteorological Office Library.

Forster devotes much of his work to cloud structure. The reason for the " comparative levity " of clouds is examined at length. A current theory was that cloud particles were hollow and contained some gas lighter than air. Forster argues against this view and is in favour of the correct explanation of a very slow rate of fall " because of their minuteness ". On the structure of cirrus cloud he was rather fantastic himself, regarding the long filaments as drawn out in some way electrically and serving as conductors of electricity to neutralise the electricity of remote masses of air. Although he knew well that wind varies with height he did not use that knowledge when considering cloud forms.

In those days, cumulonimbus with anvil was called cumulo-stratus, and regarded as produced by a cumulus cloud moving upwards and " inosculating " with cirrostratus. On the whole, however, Howard's classification of clouds, which is illustrated in this book by seven coloured figures, has stood the test of time extremely well.

Forster describes the first pilot-balloon observation in some detail. It was made by Mr. Wallis, who released " an inflammable air balloon of varnished paper 3 ft. 6 in. in diameter " from Clapton, London, on October 25, 1809. The balloon went first to west-north-west, then to south, and later north-east, as it rose. It fell at Wilbraham in Cambridgeshire. Forster himself later made over thirty similar flights, most of which he considered to indicate four or more different currents of wind. Naturally without observations of the elevation, etc., of the balloon this work was very rough.

The opinion at the time was strongly in favour of lunar influences on the weather. Forster, indeed, states " that changes of weather oftener take place about the full and new moon and about the quadratures than at other times is a fact founded on long observations." It does not seem to have been realised that with these lunar phases only seven days apart it was quite easy to ascribe changes as occurring " about " one or other of them.

For short-period forecasting the Shepherd of Banbury rules were in favour, but a great deal of space is given by Forster to prognostics based on the behaviour of animals, human aches, etc. The connexion between pressure variations, weather, and temperature were naturally hard to understand in 1815. Forster, recognising the relative lightness of warmer air, was very puzzled by occasions of rising pressure with increasing temperature.

A curious theory of " igneous " meteors to the effect that they were incandescent gases of the will-o'-the-wisp type ascending from the earth was current in 1815. Forster points out that no one had ever seen a column of burning gas rising from the earth to great heights and tentatively suggests that " igneous " meteors might be the same as aerolites, though why aerolites should burn in the upper air or where they came from, he could not see. The aurora is correctly ascribed, following Davy, to electric discharges in rarefied air.

Apart from meteorology the book contains a discussion on two matters of which much is heard today. On the first of these, whether science is pursued for the discovery of new facts or for its utility and extension of human power, Forster is wholly for discovery. The second matter, following a reflection on the decay of the ancient civilizations, is the need for the " permanent improvement of the moral and intellectual character of future generations, without which all the scientific records imaginable would be to them only as cyphers scrawled on the barrenness of intellect."

G. A. BULL

Visibility from Fairlight Down, near Hastings, Sussex, evening May 31, 1949

Fresh polar air covered the British Isles on May 30–31 and visibility was exceptionally good over much of the country.

An article by Mr. V. J. Torr in the *Hastings & St. Leonards Observer* of June 11 describing the view from Fairlight Down, 550 ft. above M.S.L. a few miles east of Hastings, Sussex, on the early evening of May 31, is of interest as illustrating the exceptional visibility.

To the north, the Darent gap, 35 miles away in the North Downs, and, to the east, Shakespear Cliff, 30 miles away, were visible. Across the Channel the higher parts of the French coast were visible from Cape Gris Nez (180 ft.) at 50 miles to the line of cliffs (about 250 ft. high) south of the Somme estuary at 70 miles distance.

Looming must be invoked to explain this visibility of the French coast, for the sea horizon from Fairlight Down is approximately 32 miles distant with normal refraction so that an eminence of at least the same height would be needed for visibility at even 64 miles. Cape Gris Nez would be barely visible from Fairlight with normal refraction as the horizon distance from it is about 19 miles. The wind was from between S. and SW. over the eastern Channel and the looming is probably to be accounted for by an inversion in air warmed over France moving out over the relatively cold sea.

It is interesting to recall the classic observation of looming made by W. Latham, F.R.S., from Hastings on July 26, 1798. On that occasion a considerable length of the French coast was seen from beach level. His account is reproduced in the " Manual of Meteorology " Vol. III, p. 58.

Record rainfall at Suva, Fiji

According to reports received from the Meteorological Office in the Fiji Islands, May 1949 was the wettest month on record at Suva with a total fall of 58·70 in., beating the previous highest of 45·45 in. in April 1941.

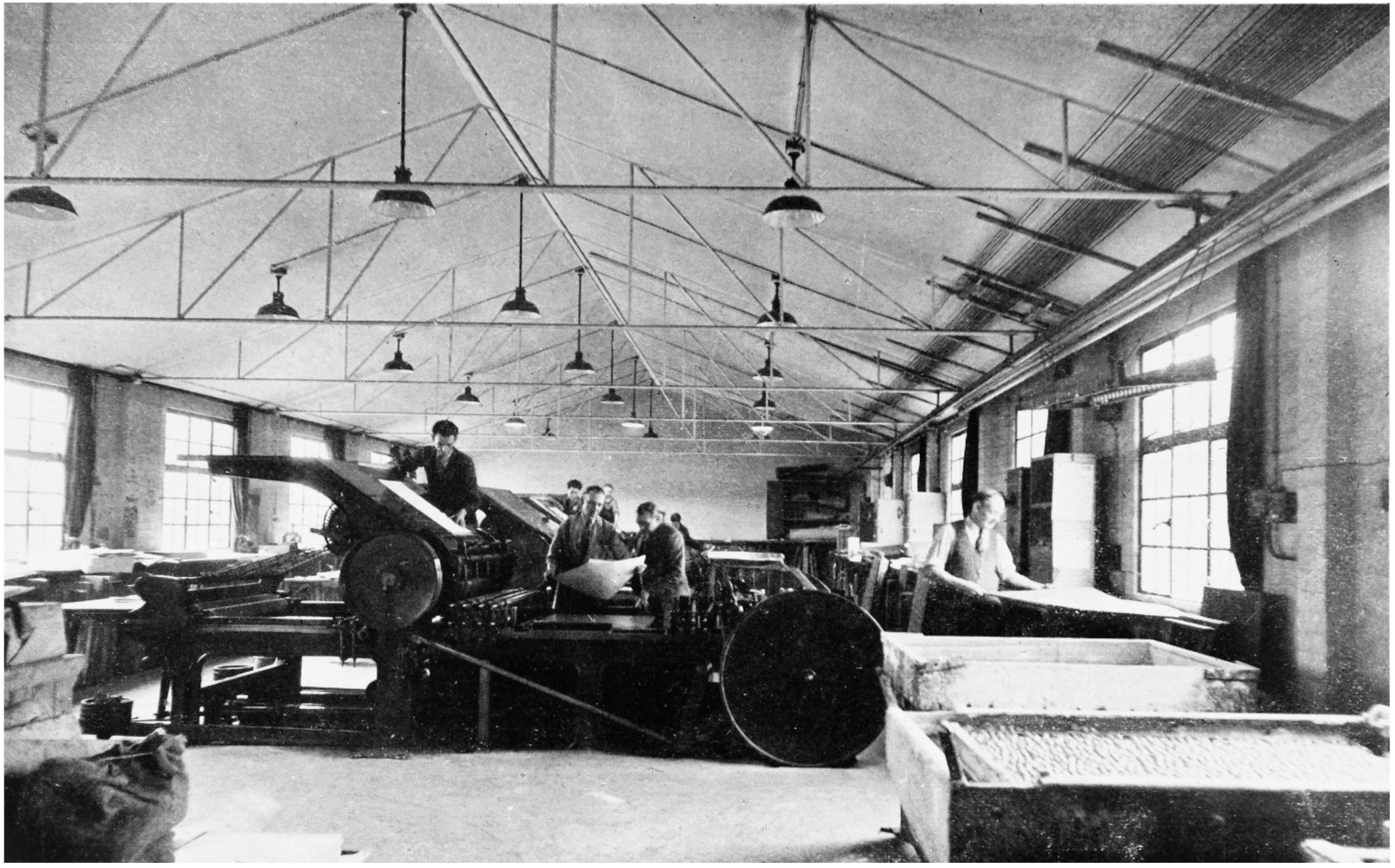
During the month, very heavy falls were recorded on the 5th of 14·53 in., on the 10th of 6·05 in., and during the night 28th–29th when 11·53 in. rain fell in a violent thunderstorm which lasted about 12 hr. An automatic gauge at Walu Bay measured a fall of 2 in. in 20 min. on the 5th. The fall of 14·53 in. on the 5th was the highest since the record daily fall of 15·91 in. which occurred on November 12, 1911.

Journal of Geophysical Research

(In continuation of *Terrestrial Magnetism and Atmospheric Electricity*)

The change of name recorded at the head of this note has been made in the title of one of the oldest of geophysical journals, with effect from No. 1 of Volume 54, March 1949.

The new editor, Dr. Merle A. Tuve, who succeeds Dr. J. A. Fleming, states in his greetings that the change of title does not represent a change in the journal itself, which is still under the control of the Carnegie Institute. The journal has for the past twenty years covered a wider field than the title indicated, having contained papers on the upper atmosphere, the ionosphere, the aurora, solar and terrestrial relationships, and investigations on the crust and interior of the earth which were not more appropriate to other specialist journals.



H.M. STATIONERY OFFICE PRESS AT DUNSTABLE, USED FOR PRINTING THE *Daily Weather Report*

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FOLDING AND DISPATCHING THE *Daily Weather Report* AT DUNSTABLE

The change of name is intended to emphasise that the journal will be developed as an avenue for publication of the scientific aspects of geophysics, as distinguished from research and development work in geophysics directed to more immediately practical ends.

Notice to users of the Climatological Table for the British Commonwealth

The publication in the *Meteorological Magazine* of the Climatological Table for the British Commonwealth beyond the present year is being considered.

Users of the Table are invited to write to the Editor to say what use they make of the various data, and to make any suggestions as to how the Table can be made more practicable.

REVIEWS

Climate through the Ages, by C. E. P. Brooks. 8vo. $8\frac{1}{2}$ in. × $5\frac{1}{4}$ in., pp. 395. Ernest Benn, London. 2nd edn. 1949. Price: 21*s.* 0*d.*

English students of climatology are very ready to complain that there are too many observations and too little literature. There are those who have reached the stage of disillusionment which is liable to follow that romantic period in one's early twenties when, freshly equipped from the Sixth Form, the synoptic chart is still a glamorous object of contemplation. But as time goes on, lacking immediate association with an active-minded forecasting office, some take up particular studies: the aurora, the forms of clouds, the elegant glories of turbulent motion. Others, contemplating the world as a whole, find their thoughts turn to the range of possibilities in space and time that the world's weather has to offer, especially if their profession or business leads them daily to consider the effect of weather on the world's diverse activities from agriculture to zoology. Within what limits must contingencies be allowed for? From that it is but a short stage to the study of climate not as an assemblage of averages but as a subject whose elucidation requires a veritable orchestra of contributory noises.

He who would thus go beyond the introductory text finds no very easy outlet. He cannot proceed under his own steam, and unless he has a rather odd mind the world-wide masses of observational material may prove astonishingly repellent. So much is gathered and so little is rendered digestible beyond the simplest stage. Even in England the reviewer has been repeatedly surprised by the utter ignorance displayed by many inquirers of the wholesome and palatable forage so easily obtained in the *Monthly Weather Report*.

With this in mind we rarely find anyone with the will and capacity to assemble for us not merely climatic material on a world-wide scale, but with regard to the whole sweep of geological time. It is no wonder that Dr. Brooks' "Climate through the Ages" has been acclaimed for over twenty years as a standard work whose international reputation is confirmed by repeated citation. In the first edition (1926) Dr. Brooks included in compact form the results of his early studies of the relationship between continentality and temperature, and the consequences of varying the extent of the Arctic ice as well as the extent and elevation of the land masses. With the aid of his fundamental training as a geologist he has done invaluable service in bringing together the results derived from a truly marvellous variety of observational material from oceanography

and geology, botany and archæology, backed by the informed grasp of meteorological principles which we have long known him to possess. And for long we have gone back to him for a guide to the extraordinary problems of climatic change, so succinctly summarised in that delightful list (in Appendix II) of the fifty or so diverse theories which have been put forward. For as our own evolution as a species in all probability owes more to climatic change than to any other environmental variable, it is no wonder that the grandeur of the problems presented by the Scandinavian erratics in Norfolk or the Jurassic flora of Spitsbergen remains for many of us surpassingly attractive. Moreover, he brings us forward to the historical period; from questions of Palæozoic glaciation we are swept through Chinese archives to the Napoleonic winters with fascinating ease.

That a new edition of this standard work should appear is opportune. The author has not made many changes; but in the light of more recent work he views sunspots with caution. As he justly says, his concept of glacial and non-glacial climates has now received general acceptance. The question that remains is why should the glacial climates develop at certain stages in the earth's history. It is well to observe how for a time many major problems of climatic change in the geological record were supposedly satisfied by a facile adoption of continental drift; and his review of the evidence may be commended.

Not the least interesting development in recent years has been the recognition by geophysicists such as Umbgrove that it is necessary to revive Brooks' scheme of rearrangement of the ocean currents, first published in the *Quarterly Journal**, as a possible explanation of the Upper Palæozoic glaciation, provoking though it remains. Dr. Brooks must have contemplated with no little pleasure the recognition by Sir George Simpson in 1934 that the eccentric position of glaciation in the northern hemisphere might well be explained by his geographical distribution of land and sea rather than by any needless and, according to some, unacceptable wanderings of the North Pole. The undeniable association of great ice ages with orogenic uplift remains, but we have still to solve the problem of multiple glaciation. Dr. Brooks may, in the past, have been criticised for his early readiness to bounce Scandinavia up and down, so to speak, to explain the several phases. He has apparently retreated from this view and justly reminds us of Sir George Simpson's elegant theory of multiple glaciation; but it is a pleasure to find (p. 377) that he still considers that the results of shifting of crustal loading may be important.

For serious complications are introduced into these arguments if we accept Professor Wager's view that the development of the Greenland ice-cap may have to be put back into the Miocene; this paper† appears to have been somewhat overlooked, but to the reviewer's knowledge has not been controverted. Some might therefore consider that the intermittent peripheral glaciation of Scandinavia and Laurentia during the Pleistocene can after all be explained by isostatic boundings following a long interval during which the seas were cooled. If so, we are confronted with the fact that we are living in an inter-glacial period, and with the problem of disposing of the high Polar ice-caps

*BROOKS, C. E. P.; The meteorological conditions during the glaciation of the present tropics, being some remarks on the climatological basis of Wegener's theory of continental drift. *Quart. J. R. met. Soc., London*, **52**, 1926, p. 251.

†WAGER, L. R.; The form and age of the Greenland ice cap. *Geol. Mag., London*, **70**, 1933, p. 145.

once formed; and this raises again the rate of dispersal of heat through the bottom of the oceans and elsewhere. It becomes evident why many regard this as one of the most desirable subjects of geophysical inquiry.

Dr. Brooks is understandably cautious with regard to " astronomical " theories of climatic change so ably restated in recent years by Professor Zeuner; that there is much to be said against such views is evident from other recent writers. We must all await the answer to many of these problems when the core-samples from the ocean bed obtained by the *Albatross* have been fully discussed. In regard to the oceans Dr. Brooks is quite invaluable for the breadth of the references he gives and for the stimulus he thus provides. For example, on pp. 72 and 79 he reminds us of the open " North Water " of Baffin's Bay; it brings to mind at once a possible explanation of the relatively mild ice-age climate of the Lofotens, allowing the survival of plants at a time when even the greater part of distant Ireland lay under ice. Elsewhere he has re-interpreted the African data in a way which will be interesting to all students of that continent; reference to Nilsson's more recent work might have been added. With regard to Greenland, recent Danish work points to the effect of drought as well as cold in the mediæval Norse economy.

Progress in recent years has been rapid and, in the light of later work, Dr. Brooks might have aded more to the chapter on climatic fluctuations in the historical period, having regard, for example, to the later results of the pollen-analysts. He pays relatively little attention to the events of the late-glacial epoch and it is now evident from the Windermere lake deposits and elsewhere that one of the most important climatic fluctuations to explain is the prolonged "Allerod oscillation ". This relatively settled warmer phase followed that period of rapid waning of the Scandinavian ice which according to Mannerfelt was demonstrably due to increased storminess; and in turn the subsequent post-Allerød climatic recession cannot practicably be associated with changes in the extent of land and sea. Estimates of the mean temperature of subsequent post-glacial periods in Denmark have recently been contributed by Iversen* and might have been added, as they give a valuable index of the range of variation. The development of Pettersson's theory of tide-generating force (p. 369) offers a welcome indication of the way in which sudden variations in the extent of the arctic ice might arise. Can they in any way be associated with the curious interval of about 900 years between the recurrence horizons in the peat bogs, recently discussed by Dr. Verona Conway? In this connexion his bold and attractive diagram on p. 361 will give many food for thought.

In the historical period more account might have been taken of the recent work of Thorarinsson, who has shown that the Icelandic glaciers reached their maximum extent in historical times much later than (p. 303) the first half of the fourteenth century. This statement is amended in part on p. 375, but Thorarinsson has now put the greatest advances in the eighteenth or nineteenth century. On the same page it might be questioned whether any temperature change likely to have occurred in the sixteenth century would allow European glaciers to be " frozen to the ground ". That there should be some delay between the accumulation of heavy snowfalls and catastrophic glacier advance is understandable; how long, we do not yet know.

*IVERSEN, J.; Viscum, Hedera and Ilex as climate indicators. *Geol. Fören. Stockh. Förh., Stockholm*, **66**, 1944, p. 463.

Dr. Brooks points (p. 372) to the great storm floods in the North Sea coming before the maximum of Pettersson's tide-generating force. In the light of recent studies can we not also ascribe them to the displacement of deep lows towards the south Norwegian coast, which might in turn owe something to the contemporary spread of the Greenland ice? These minor problems of the " historical " phase appear at first to be insignificant against the vast sweep of Dr. Brooks' earlier chapters, but we are aware how often the explanation of the larger events may be sought in the processes we know to have been operative on the smaller scale, as in the " little ice age ".

Some may think that Dr. Brooks is a little discouraging in his attitude to " chance variations " of the vigour of the atmospheric circulation (pp. 66 and 377)—" changes which may have no external cause ". Far be it from our students of high-altitude radiation to be distracted from trying to prove that they hold a master-key over-ruling those terrestrial variables which the geographer is wont to find so attractive. There is nevertheless new hope for the earth-bound field-worker as the glaciologists and botanists have shown; and Dr. Brooks has demonstrated what a fascinating variety of evidence must be brought together before we can build up a coherent scheme of the variations to which the world's climate has been subject. He can indeed look with pride on his own contributions. We can now appreciate how some of his earlier ideas are finding renewed support, and with what wisdom he himself reminds us that there have been other contributors whose concepts with regard to the effect of volcanic dust or of carbon dioxide may yet be shown to have some validity in regard to climatic change.

Scientists in many fields owe a great debt to Dr. Brooks for a stimulating conspectus; and if even he, with his magnificent sweep, has not quite overtaken some of the most recent literature in a gigantic field, he can reflect on how much he himself has done to arouse interest in these problems through his original work and the invaluable summaries he has provided. Few indeed can be found capable of thinking in such world-wide terms, and it is to be hoped that he will be able to take up again some of the implications of his earlier work. Geologists and geographers will continue to find his book indispensable for its material and exemplary in its comprehension and critical handling of data; meteorologists retreating from the synoptic chart will be encouraged to renew their study of the fundamental physics of the atmosphere; and many more general readers will find their questions answered. The book is well produced; minor errors in the first edition (*e.g.* Fig. 22) have been corrected. A small error arises in the index where under " Matthes " a reference on p. 316 is given which does not there exist. On pp. 307–8 it might be added that the Towneley rainfall measurements are available from 1677–1703.

GORDON MANLEY

Present climatic fluctuation, by H. W. Ahlmann, and *Problem of the Great Ross Barrier*, by F. Debenham. *Geographical Journal, London*, **112**, 1949, pp. 165–95 and 196–218.

Most articles in the *Geographical Journal* are of meteorological interest. In the April number there are two of very special interest. These are Prof. Ahlmann's paper on the " Present Climatic Fluctuation " and Prof. Debenham's on the " Problem of the Great Ross Barrier ".

Prof. Ahlmann's paper is probably the most comprehensive general survey in existence of the climatic changes of the past hundred years, and a study of it is recommended to all meteorologists. The evidence of a general warming and increasing dryness is very impressive. In Greenland the change is so marked that the Danish Prime Minister was able to say, in November 1948, that a new era had begun for that country.

Prof. Debenham discusses many features of the Ross barrier ice sheet but the main subject of discussion is whether it melts or freezes at the bottom in the outer parts where it is known to be over the sea. Arguing from the fact that marine deposits are found on top of the sheet he concludes that it is fed by freezing at the bottom. G. A. BULL

OBITUARIES

Mr. Albert Wilson, who died on May 15 at the age of 86, became interested in weather recording in 1872 when, at the age of 9, he started to measure rainfall under the supervision of his father. He sent records for publication in *British Rainfall* from 1892 until his death, the observations being made first at Bradford and subsequently at Ilkley, Garstang, Sedbergh, Tynygroes (Caernarvon) and finally at Carnforth.

With his brother, Mr. Sydney Wilson, he set up several monthly gauges on mountain sites at the turn of the century and maintained some of these records for 25 years.

Mr. Wilson was a Fellow of the Royal Meteorological Society and of the Linnean Society. He was a keen botanist and author of "The flora of Westmoreland", "The altitudinal range of British plants" and a number of papers on botanical and meteorological subjects.

It is a pleasure to learn that his interest in rainfall observation is shared by his son, Mr. Howard Wilson, who is continuing the record at Priest Hutton, near Carnforth.

Dr. G. Ainslie Johnston set up a rain-gauge at Ambleside in February 1895 and made regular observations until his death on June 4, 1949, a period of 54 years. Few observers have maintained a homogeneous series of observations for so long. The records have been published in the annual volumes of *British Rainfall*.

ERRATUM

July 1949, facing PAGE 201; beneath the photograph, *insert* "*Reproduced by courtesy of the U.S. Navy.*"

WEATHER OF JUNE 1949

Mean pressure was 1020 mb. or slightly over at the Azores, in the southern parts of England and Ireland, in Belgium and northern France, and northward of Scandinavia, and was between 1005 and 1010 mb. over an area nearly 1,000 miles in diameter south of Greenland. It was about 1015 mb. over most of North America, but below 1010 mb. in the north-west of Mexico and over part of central Canada. Deviations from the normal were small in western Europe and North America, but were between −5 and −8 mb. over most of the area of low pressure south of Greenland, and between +6 mb. and +8 mb. off the north-east coast of Greenland.

The weather over the British Isles was dry and warm with a large excess of sunshine. At Renfrew and Stornoway it was the sunniest June on record, while at Leuchars the total sunshine equalled the previous record of 1940. Rainfall was well below the average preliminary values for the percentages of the average for the period 1881–1915 being 30 over England and Wales, 59 over Scotland and 43 over Northern Ireland.

During the first four days depressions were situated off the west of Scotland, while troughs of low pressure moved north-east over the British Isles; rain fell in most places and thunderstorms occurred, the latter being rather widespread on the 1st and 2nd. Temperature during this period was rather low. On the 5th a wedge of high pressure moved east across the country and fair, sunny weather prevailed, though rain occurred locally in the west and north later. Thereafter a depression moved east-north-east off our northern seaboard and an associated trough moved east over the British Isles giving gales in the northern half of the country and slight rain, except in south-east and east England. The wind gusted up to 52 kt. at Durham and 48 kt. at Tiree and at Bidston Observatory on the 6th. On the 7th a complex area of low pressure moved across the country, giving scattered thunderstorms. On the 9th an anticyclone over Scotland moved east and was followed by a weak trough of low pressure; fair weather prevailed except in the north of Scotland. On the 10th further rain fell in the northern half of the country, but fair weather persisted in southern England. On the 12th and 13th a weak trough of low pressure moved south-east over the British Isles giving some rain in many areas but the rain did not reach the south of England until the 13th.

Subsequently an anticyclone moved north-east to the Faeroes where it remained almost stationary, with a wedge extending southward over the British Isles, until the 26th; it then moved slowly east in front of a weak trough off our north-west seaboard. Dry, sunny, rather cool weather prevailed until the 20th, when temperature rose, the weather continuing sunny and dry. On the 26th a new anticyclone off our south-west coasts moved slowly east, while a trough approached our western coast and subsequently moved very slowly east. Fair, very warm weather prevailed over much of the country, though some rain fell at times in Scotland and Ireland; rain was recorded in northern England also on the 28th. By the 29th pressure was high in an anticyclone over Scotland; this system moved rather quickly north-east and, in its rear, another trough moving north-east caused further rain in Scotland and Ireland on the night of June 30–July 1.

The general character of the weather is shown by the following provisional figures:—

	Air Temperature			Rainfall		Sunshine	
	Highest	Lowest	Difference from average daily mean	Percentage of average	No. of days difference from average	Percentage of average	Percentage of possible duration
	°F.	°F.	°F.	%		%	%
England and Wales ..	90	32	+1·8	30	−6	125	50
Scotland	84	28	+1·2	59	−8	137	47
Northern Ireland ..	83	36	+2·5	43	−6	147	50

RAINFALL OF JUNE 1949

Great Britain and Northern Ireland

County	Station	In.	Per cent of Av.	County	Station	In.	Per cent of Av.
London	Camden Square ..	·71	35	*Glam.*	Cardiff, Penylan ..	·65	26
Kent	Folkestone, Cherry Gdn.	·61	31	*Pemb.*	St. Ann's Head ..	·24	11
,,	Edenbridge, Falconhurst	·57	26	*Card.*	Aberystwyth	·49	20
Sussex	Compton, Compton Ho.	·81	33	*Radnor*	Tyrmynydd	·88	27
,,	Worthing, Beach Ho.Pk.	·77	44	*Mont.*	Lake Vyrnwy	1·41	43
Hants	Ventnor, Roy. Nat. Hos.	·39	21	*Mer.*	Blaenau Festiniog ..	2·49	38
,,	Bournemouth	·39	19	*Carn.*	Llandudno	·42	22
,,	Sherborne St. John ..	·30	14	*Angl.*	Llanerchymedd ..	·64	27
Herts.	Royston, Therfield Rec.	·96	43	*I. Man.*	Douglas, Borough Cem.	·38	16
Bucks.	Slough, Upton	·27	13	*Wigtown*	Port William, Monreith	·72	31
Oxford	Oxford, Radcliffe ..	·46	21	*Dumf.*	Dumfries, Crichton R.I.	·87	34
N'hant.	Wellingboro', Swanspool	·50	24	,,	Eskdalemuir Obsy. ..	1·31	42
Essex	Shoeburyness	·62	35	*Roxb.*	Kelso, Floors	·87	41
Suffolk	Campsea Ashe, High Ho.	·49	26	*Peebles*	Stobo Castle	1·08	46
,,	Lowestoft Sec. School ..	·36	20	*Berwick*	Marchmont House ..	1·15	50
,,	Bury St. Ed., Westley H.	·77	37	*E. Loth.*	North Berwick Res. ..	1·33	80
Norfolk	Sandringham Ho. Gdns.	1·04	48	*Midl'n.*	Edinburgh, Blackf'd. H.	1·01	51
Wilts.	Bishops Cannings ..	·47	19	*Lanark*	Hamilton W. W., T'nhill	1·15	52
Dorset	Creech Grange.. ..	·47	20	*Ayr*	Colmonell, Knockdolian	·81	32
,,	Beaminster, East St. ..	·45	20	,,	Glen Afton, Ayr San ..	1·00	33
Devon	Teignmouth, Den Gdns.	·82	43	*Bute*	Rothesay, Ardencraig	1·29	42
,,	Cullompton	·93	44	*Argyll*	L. Sunart, Glenborrodale	3·09	96
,,	Barnstaple, N. Dev. Ath.	·49	22	,,	Poltalloch	1·60	52
,,	Okehampton, Uplands	·58	21	,,	Inverary Castle ..	1·71	43
Cornwall	Bude School House ..	·32	16	,,	Islay, Eallabus ..	1·08	41
,,	Penzance, Morrab Gdns.	·75	34	,,	Tiree	1·33	52
,,	St. Austell, Trevarna ..	1·49	57	*Kinross*	Loch Leven Sluice ..	1·49	68
,,	Scilly, Tresco Abbey ..	·41	24	*Fife*	Leuchars Airfield ..	·92	55
Glos.	Cirencester	·58	24	*Perth*	Loch Dhu	2·38	57
Salop.	Church Stretton ..	·59	23	,,	Crieff, Strathearn Hyd.	1·31	50
,,	Cheswardine Hall ..	·67	27	*Perth*	Pitlochry, Fincastle ..	1·63	78
Worcs.	Malvern, Free Library	·42	18	*Angus*	Montrose, Sunnyside ..	1·35	81
Warwick	Birmingham, Edgbaston	·25	11	*Aberd.*	Braemar	1·26	64
Leics.	Thornton Reservoir ..	·57	26	,,	Dyce, Craibstone ..	1·93	103
Lincs.	Boston, Skirbeck ..	·79	43	,,	Fyvie Castle	1·25	60
,,	Skegness, Marine Gdns.	·87	48	*Moray*	Gordon Castle	1·18	58
Notts.	Mansfield, Carr Bank ..	·76	34	*Nairn*	Nairn, Achareidh ..	1·09	62
Derby	Buxton, Terrace Slopes	1·94	60	*Inv's*	Loch Ness, Foyers ..	1·21	55
Ches.	Bidston Observatory ..	·89	40	,,	Glenquoich	2·87	58
Lancs.	Manchester, Whit. Park	·83	31	,,	Fort William, Teviot ..	2·55	72
,,	Stonyhurst College ..	1·13	37	,,	Skye, Duntuilm ..	2·08	80
,,	Blackpool	·51	23	*R. & C.*	Ullapool	1·53	67
Yorks.	Wakefield, Clarence Pk.	·47	22	,,	Applecross Gardens ..	2·44	85
,,	Hull, Pearson Park ..	·41	20	,,	Achnashellach	2·38	63
,,	Felixkirk, Mt. St. John	·81	37	,,	Stornoway Airfield ..	1·08	49
,,	York Museum	·57	28	*Suth.*	Lairg	1·11	62
,,	Scarborough	·73	40	,,	Loch More, Achfary ..	2·71	73
,,	Middlesbrough.. ..	·53	28	*Caith.*	Wick Airfield	1·40	78
,,	Baldersdale, Hury Res.	·75	32	*Shetland*	Lerwick Observatory ..	1·03	58
Norl'd.	Newcastle, Leazes Pk. ..	1·49	71	*Ferm.*	Crom Castle	1·54	57
,,	Bellingham, High Green	·82	36	*Armagh*	Armagh Observatory ..	·98	39
,,	Lilburn Tower Gdns. ..	·84	41	*Down*	Seaforde	·50	18
Cumb.	Geltsdale	·66	24	*Antrim*	Aldergrove Airfield ..	·58	24
,,	Keswick, High Hill ..	·80	27	,,	Ballymena, Harryville..	1·45	50
,,	Ravenglass, The Grove	·65	25	*L'derry*	Garvagh, Moneydig ..	1·17	46
Mon.	Abergavenny Larchfield	·71	29	,,	Londonderry, Creggan	1·81	64
Glam.	Ystalyfera, Wern House	·72	19	*Tyrone*	Omagh, Edenfel ..	1·31	46

CLIMATOLOGICAL TABLE FOR THE BRITISH COMMONWEALTH, FEBRUARY 1949

(See Notice on p. 237)

Stations	Pressure		Temperatures							Relative humidity	Mean cloud amount	Precipitation			Bright Sunshine	
			Absolute		Mean values											
	Mean of day M.S.L.	Diff. from normal	Max.	Min.	Max.	Min.	½ Max. and Min.	Diff. from normal	Wet bulb			Total	Diff. from normal	Days	Daily mean	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F	%	oktas	in.	in.		hr.	%
London, Kew Observatory	1027·5	+12·5	55	23	48·7	34·9	41·8	+1·1	38·6	89	4·0	0·88	−0·66	9	3·8	38
Gibraltar	1025·7	+5·7	67	45	62·6	52·4	57·5	+1·7	53·0	79	3·9	2·38	—	5	6·6	61
Malta	1022·7	+6·6	65	39	58·6	48·3	53·5	−1·8	52·5	78	5·3	2·50	—	7	5·5	51
St. Helena	1013·6	+1·1	81	61	78·3	62·9	70·6	+5·3	63·3	96	6·9	0·83	−1·91	8	—	—
Lungi, Sierra Leone	1011·0	—	94	68	88·4	72·9	80·7	—	73·3	86	2·1	0·00	—	0	—	—
Lagos, Nigeria ..	1010·5	+0·8	97	64	93·0	71·4	82·2	−0·3	74·7	74	4·3	0·08	—	1	5·1	43
Kaduna, Nigeria ..	1004·5	—	97	54	89·4	61·0	75·2	−2·5	54·1	17	1·9	0·00	−0·02	0	7·2	61
Chileka, Nyasaland	1012·5	+0·4	95	61	85·1	66·5	75·8	+1·6	67·3	70	4·6	1·58	−6·50	10	7·1	56
Lusaka, Rhodesia ..	1011·4	+0·3	88	58	80·6	61·6	71·1	+0·4	65·1	86	5·5	3·18	−5·44	13	7·1	56
Salisbury, Rhodesia	1012·3	+0·2	87	52	78·4	58·3	68·3	0·6	61·1	73	4·0	4·75	−2·14	9	6·9	54
Cape Town	1013·7	+0·3	95	58	82·6	62·4	72·5	+2·2	59·7	62	3·1	0·20	−0·38	3	—	—
Palmiefontein, S. Africa	—	—	87	50	79·2	55·8	67·5	—	58·5	70	4·0	1·90	—	11	8·9	—
Mauritius																
Calcutta, Alipore Obsy.	1012·2	−1·3	96	51	85·4	60·6	73·0	+1·8	61·0	73	0·7	0·03	−0·96	1	9·5	83
Bombay	1012·0	−0·7	101	59	85·4	68·3	76·9	+1·2	66·2	74	1·0	0·00	−0·03	0	9·8	85
Madras	1012·3	−0·6	96	64	88·3	68·3	78·3	+0·6	68·9	81	3·3	0·00	−0·30	0	10·0	85
Colombo, Ceylon ..	1010·7	0·1	93	61	88·2	69·8	79·0	−1·4	70·3	89	3·5	0·14	−1·80	2	9·1	76
Singapore	1009·2	−1·0	93	71	88·3	74·1	81·2	+1·0	75·3	79	6·1	4·94	−1·68	14	—	—
Hongkong	1017·3	−1·3	77	49	67·8	57·7	62·7	+3·6	58·5	81	—	4·96	+3·13	8	4·7	41
Sydney, N.S.W. ..	1009·8	−4·1	92	54	78·8	65·0	71·9	+0·6	66·3	70	4·7	6·55	+2·35	10	7·0	52
Melbourne	1010·5	−4·0	88	42	73·6	53·9	63·7	−3·0	56·3	60	4·1	2·43	+0·72	7	7·8	58
Adelaide	1012·9	−1·4	82	50	74·5	57·8	66·1	7·9	57·8	55	5·0	2·50	+1·78	8	6·9	52
Perth, W. Australia			100	57	87·7	64·7	76·2	+2·1	64·3	46	2·0	0·27	−0·18	1	9·7	74
Coolgardie	1011·8	−0·6	96	50	85·9	60·1	73·0	−3·2	59·5	52	3·3	0·92	+0·07	5	—	—
Brisbane	1009·8	−2·7	92	65	85·2	70·8	78·0	+1·5	71·9	73	5·8	6·81	+0·47	13	6·1	47
Hobart, Tasmania	1006·4	−6·8	73	41	65·4	48·4	56·9	−5·4	49·6	56	5·9	1·14	−0·34	10	7·1	51
Wellington, N.Z. ..	1011·6	−2·2	77	47	70·5	56·4	63·5	+2·3	59·4	78	5·7	1·29	−1·85	10	6·7	49
Suva, Fiji	1008·9	+1·1	89	71	85·4	74·7	80·1	−0·2	76·3	83	5·5	7·23	−3·49	21	6·6	52
Apia, Samoa ..	1008·5	+0·3	89	72	86·5	74·0	80·3	0·0	77·5	80	5·8	8·51	−6·38	20	5·9	47
Kingston, Jamaica	1016·6	+1·3	90	65	87·5	67·4	77·5	+1·0	71·3	73	1·7	0·02	−0·58	1	9·0	78
Grenada, W. Indies	..	—	87	70	83·0	71·0	78·5	+1·4	72·0	74	4·4	2·45	−0·33	18	—	—
Toronto	1019·4	+1·4	53	4	36·5	22·1	29·3	+8·2	25·4	80	5·3	2·83	+0·45	12	3·8	36
Winnipeg	1021·1	−0·7	24	−34	3·5	−15·8	−6·1	−6·2	−10·4	—	3·1	1·07	+0·34	14	4·2	42
St. John, N.B. ..	1018·3	+4·4	47	−6	31·3	14·2	22·7	+2·8	17·1	85	4·5	4·11	+0·21	11	4·8	46
Victoria, B.C. ..	1010·8	−5·8	55	16	43·9	28·7	35·9	4·6	32·3	88	5·4	6·86	+3·60	18	3·5	34